AVT Pike

Technical Manual

V4.0.0

15 January 2008

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ALLIED
Vision Technologies

Legal notice

For customers in the U.S.A.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However there is no guarantee that interferences will not occur in a particular installation. If the equipment does cause harmful interference to radio or television reception, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the distance between the equipment and the receiver.
- Use a different line outlet for the receiver.
- Consult a radio or TV technician for help.

You are cautioned that any changes or modifications not expressly approved in this manual could void your authority to operate this equipment. The shielded interface cable recommended in this manual must be used with this equipment in order to comply with the limits for a computing device pursuant to Subpart B of Part 15 of FCC Rules.

For customers in Canada

This apparatus complies with the Class B limits for radio noise emissions set out in the Radio Interference Regulations.

Pour utilisateurs au Canada

Cet appareil est conforme aux normes classe B pour bruits radioélectriques, spécifiées dans le Règlement sur le brouillage radioélectrique.

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Configuration of the camera

Introduction

Document history

Version	Date	Remarks
V2.0.0	07.07.2006	New Manual - RELEASE status
PRE_V3.0.0	22.09.2006	Minor corrections Added Pike F-145 Pike F-210 AOI frame rates corrected: Chapter PIKE F-210: AOI frame rates (no sub-sampling) on page 232 New advanced registers: Chapter Advanced features on page 278
V3.0.1	29.09.2006	Minor corrections
V3.1.0	13.02.2007	Changed camera status register (Table 137: Camera status register on page 285) Added description for the following mode *Output state follows PinState bit (Table 40: Output routing on page 104)* Added M39-Mount for Pike F-201 and F-421 (Chapter F-Mount, K-Mount, M39-Mount on page 82)
to be continued on next page		

Table 1: Document history

Version	Date	Remarks
	continued from last page	
V3.2.0	22.08.2007	Minor corrections Added CE in Chapter Declarations of conformity on page 14. Added Value field in Table 48: Shutter CSR on page 120. Added Chapter Cross section: CS-Mount (only PIKE F-032B/C) on page 78. Added detailed description of BRIGHTNESS (800h) in Table 130: Feature control register on page 272 Added detailed description of WHITE-BALANCE (80Ch) in Table 130: Feature control register on page 272 et seq. Added Appendix, Chapter Sensor position accuracy of AVT cameras on page 322. Added new frame rates in Chapter Specifications on page 36 Added new AOI frame rates and diagrams in Chapter Frame rates Format_7 on page 220 New minimum shutter speeds for each of the Pike cameras in Chapter Specifications on page 36 and the following Added new features of PIKE update round: • SIS: see Chapter Secure image signature (SIS): definition and scenarios on page 198 • Sequence mode: see Chapter Sequence mode on page 189 • Smear reduction see Chapter Smear reduction on page 200 • 4 x / 8 x binning and sub-sampling modes see Chapter Binning (only PIKE b/w models) on page 135 see Chapter Sub-sampling (PIKE b/w and color) on page 142 see Chapter Binning and sub-sampling access on page 149 • Quick mode for format changes see Chapter Quick parameter change timing modes on page 151 • Speed increase mode (Packed 12-bit Mode) Chapter Packed 12-Bit Mode on page 156 • CS-Mount (only for PIKE F-032) Chapter PIKE F-032B / F-032B fiber on page 37, Chapter PIKE F-032C / F-032C fiber on page 39 and Chapter Cross section: CS-Mount (only PIKE F-032B/C) on page 78
	to be continued on next page	

Table 1: Document history

Version	Date	Remarks
		continued from last page
V4.0.0	15.01.2008	Added 15fps versions of PIKE F-145 at Table 135: Camera type ID list on page 282 Added VERSION_INFO1_EX, VERSION_INFO3_EX and description at Table 134: Extended version information register on page 281 Revised Chapter Secure image signature (SIS) on page 312 Added detailed description to register 0xF10000570 PARAMUPD_TIMING (how to switch on Quick Format Change Mode) see Chapter Quick parameter change timing modes on page 307 Added Chapter PIKE F-505B / F-505B fiber on page 57 and Chapter PIKE F-505C / F-505C fiber on page 59. Added Chapter PIKE F-505B / PIKE F-505C on page 211. Revised description of C-Mount adjustment in Chapter Adjustment of C-Mount on page 81. Moved AVT Glossary from Appendix of PIKE Technical Manual to AVT Website. Revised PIKE F-505B/C data. Corrected binning (only **b/w** cameras) and added **Format_IDs** in Figure 86: Mapping of possible Format_7 modes to F7M1...F7M7 on page 150.

Table 1: Document history

Conventions used in this manual

To give this manual an easily understood layout and to emphasize important information, the following typographical styles and symbols are used:

Styles

Style	Function	Example
Bold	Programs, inputs or highlighting important things	**bold**
Courier	Code listings etc.	`Input`
Upper case	Register	REGISTER

Table 2: Styles

Style	Function	Example
Italics	Modes, fields	*Mode*
Parentheses and/or blue	Links	(Link)

Table 2: Styles

Symbols

Note

This symbol highlights important information.

Caution

This symbol highlights important instructions. You have to follow these instructions to avoid malfunctions.

www

This symbol highlights URLs for further information. The URL itself is shown in blue.

Example:

http://www.alliedvisiontec.com

Before operation

We place the highest demands for quality on our cameras. This Technical Manual is the guide to the installation and setting up of the camera for operation. You will also find the specifications and interfaces here.

Please read through this manual carefully before operating the camera.

Declarations of conformity

Allied Vision Technologies declares under its sole responsibility that the following products

Category Name	Model Name
Digital Camera (IEEE 1394)	PIKE F-032B
	PIKE F-032C
	PIKE F-032B fiber
	PIKE F-032C fiber
	PIKE F-100B
	PIKE F-100C
	PIKE F-100B fiber
	PIKE F-100C fiber
	PIKE F-145B*
	PIKE F-145C*
	PIKE F-145B fiber*
	PIKE F-145C fiber*
	PIKE F-210B
	PIKE F-210C
	PIKE F-210B fiber
	PIKE F-210C fiber
	PIKE F-421B
	PIKE F-421C
	PIKE F-421B fiber
	PIKE F-421C fiber
	PIKE F-505B
	PIKE F-505C
	PIKE F-505B fiber
	PIKE F-505C fiber

Table 3: Model names

to which this declaration relates are in conformity with the following standard(s) or other normative document(s):

- EN 55022
- EN 55024
- EN 61000
- FCC Class B
- CE
- RoHS (2002/95/EC)

Following the provisions of 89/336/EEC directive(s), amended by directive 91/263 EEC, 92/31/EEC and 93/68/EEC.

*: also -15fps variant

Safety instructions

Note

- There are no switches or parts inside the camera that require adjustment. The guarantee becomes void upon opening the camera casing.
- If the product is disassembled, reworked or repaired by other than a recommended service person, AVT or its suppliers will take no responsibility for the subsequent performance or quality of the camera.
- The camera does NOT generate dangerous voltages internally. However, because the IEEE 1394b standard permits cable power distribution at voltages higher than 24 V, various international safety standards apply.

Reference documents applicable in the United States

The reference documents include

- Information Processing and Business Equipment, UL 478
- National Electric Code, ANSI/NFPA 70
- Standard for the Protection of Electronic Computer/Data-Processing Equipment, ANSI/NFPA 75

Reference documents applicable in Europe

The reference documents include materials to ensure the European Union CE marking as follows:

- Telecommunications Terminal Equipment (91/263/EEC)
- EMC Directive (89/339/EEC)
- CE Marking Directive (93/68/EEC)
- LOW Voltage Directive (73/23/EEC) as amended by the CE Marking

Reference documents applicable in Japan

The reference documents include:

- Electronic Equipment Technology Criteria by the Ministry of Trading and Industry (Similar to NFPA 70)

- Wired Electric Communication Detailed Law 17 by the Ministry of Posts and Telecom Law for Electric Equipment
- Dentori law issued by the Ministry of Trading and Industry
- Fire law issued by the Ministry of Construction

Cautions

Caution

- Make sure NOT to touch the shield of the camera cable connected to a computer and the ground terminal of the lines at the same time.
- Use only DC power supplies with insulated cases. These are identified by having only TWO power connectors.
- Although IEEE 1394b is functionally plug and play, the physical ports may be damaged by excessive ESD (electrostatic discharge), when connected under powered conditions. It is good practice to ensure proper grounding of computer case and camera case to the same ground potential, before plugging the camera cable into the port of the computer. This ensures that no excessive difference of electrical potential exists between computer and camera.
- If you feel uncomfortable with the previous advice or if you have no knowledge about the connectivity of an installation, we strongly recommend powering down all systems before connecting or disconnecting a camera.

Environmental conditions

Housing temperature (when camera in use):	+ 5 °C ... + 50 °C
Ambient temperature during storage:	- 10 °C ... + 60 °C

Relative humidity:	20 % ... 80 % without condensation
Protection:	IP 30

PIKE types and highlights

With Pike cameras, entry into the world of digital image processing is simpler and more cost-effective than ever before.

With the new Pike, Allied Vision Technologies presents the broadest range of cameras in the market with IEEE 1394b interfaces. Moreover, with daisy chain as well as Direct Fiber technology they gain the highest level of acceptance for demanding areas of use in manufacturing industry.

Allied Vision Technologies can provide users with a range of products that meet almost all the requirements of a very wide range of image applications.

The industry standard IEEE 1394 (FireWire or i.Link) facilitates the simplest computer compatibility and bidirectional data transfer using the plug & play process. Further development of the IEEE 1394 standard has already made 800 Mbit/second possible – and the firewire roadmap is already envisaging 1600 Mbit/second, with 3.2 Gbit/second as the next step. Investment in this standard is therefore secure for the future; each further development takes into account compatibility with the preceding standard, and vice versa, meaning that IEEE 1394b is reverse-compatible with IEEE 1394a. Your applications will grow as technical progress advances.

For further information on FireWire read Chapter FireWire on page 21.

The AVT Pike family consists of five IEEE 1394b C-Mount cameras, which are equipped with highly sensitive high-quality CCD sensors.

Each of these cameras is available in black/white and color versions.

A large selection of different sensor sizes (type 1/3, type 2/3, type 1, type 1.2) and resolutions ensures the suitability of the cameras for all applications.

The Pike family consists of the following models:

Pike type	Sensor	Picture size (max.) Format_7 Mode_0	Frame rates, full resolution
PIKE F-032B/C PIKE F-032B/C fiber	Type 1/3 KODAK KAI-340 Progressive Scan CCD imager	640 (h) x 480 (v)	Up to 208 fps
PIKE F-100B/C PIKE F-100B/C fiber	Type 2/3 KODAK KAI-1020 Progressive Scan CCD imager	1000 (h) x 1000 (v)	Up to 60 fps
PIKE F-145B/C PIKE F-145B/C fiber	Type 2/3 SONY ICX285 Progressive Scan CCD imager	1388 (h) x 1038 (v)	Up to 30 fps
PIKE F-145B/C-15fps PIKE F-145B/C-15fps fiber	Type 2/3 SONY ICX285 Progressive Scan CCD imager	1388 (h) x 1038 (v)	Up to 16 fps

Table 4: PIKE camera types

Pike type	Sensor	Picture size (max.) Format_7 Mode_0	Frame rates, full resolution
PIKE F-210B/C PIKE F-210B/C fiber	Type 1 KODAK KAI-2093 Progressive Scan CCD imager	1920 (h) x 1080 (v)	Up to 31 fps
PIKE F-421B/C PIKE F-421B/C fiber	Type 1.2 KODAK KAI-4021 Progressive Scan CCD imager	2048 (h) x 2048 (v)	Up to 16 fps
PIKE F-505B/C PIKE F-505B/C fiber	Type 2/3 SONY ICX625 Progressive Scan CCD imager	2456 (h) x 2058 (v)	Up to 15 fps

Table 4: PIKE camera types

Operating in 8-bit and 14-bit mode, the cameras ensure very high quality images under almost all circumstances. The Pike is equipped with an asynchronous trigger shutter as well as true partial scan, and integrates numerous useful and intelligent Smart Features for image processing.

Note

- All **color models** are equipped with an **optical filter** to eliminate the influence of infrared light hitting the sensor. Please be advised that, as a side effect, this filter reduces sensitivity in the visible spectrum. The optical filter is part of the back focus ring, which is threaded into the C-Mount.
- **B/w models** come with a **sensor protection glass** mounted in the back focus ring.
- **Changing filters** is achieved by changing back focus rings with the appropriate filter already mounted. Please be advised that back focus adjustment will be necessary in order to match C-Mount distance of 17.526 mm after changing back focus ring. Ask your dealer for further information or assistance.

Warning

Mount/dismount lenses and filters in a **dust-free environment**, and **do not** use compressed air (which can push dust into cameras and lenses).

Use only **optical quality tissue**/cloth if you must clean a lens or filter.

Warning

Special warning for all PIKE models with GOF connectors:

GOF connectors are very sensitive. Any dust or dirt may cause damage.

- Always keep the GOF connector and optical fiber plug clean.
- If GOF connection is not in use, keep GOF dust cover on the GOF connector.
- Reduce mating cycles to a minimum to prevent abrasion.
- Please note that optical fiber cables have a very limited deflection curve radius.

FireWire

Overview

FireWire provides one of the most comprehensive, high-performance, cost-effective solutions platforms. **FireWire** offers very impressive throughput at very affordable prices.

Definition

FireWire (also known as **i.Link** or **IEEE 1394**) is a personal computer and digital video serial bus interface standard, offering high-speed communications and isochronous real-time data services. **FireWire** has low implementation costs and a simplified and adaptable cabling system.

Figure 1: FireWire Logo

IEEE 1394 standards

FireWire was developed by Apple Computer in the late 1990s, after work defining a slower version of the interface by the IEEE 1394 working committee in the 1980s. Apple's development was completed in 1995. It is defined in IEEE standard 1394 which is currently a composite of three documents:

- the original IEEE Std. 1394-1995
- the IEEE Std. 1394a-2000 amendment
- the IEEE Std. 1394b-2002 amendment

FireWire is used to connect digital cameras, especially in industrial systems for machine vision. An advantage over USB is its faster effective speed and higher power distribution capabilities. Multi-camera applications are easier to set up than in USB.

Why use FireWire?

Digital cameras with on-board **FireWire** (IEEE 1394a or 1394b) communications conforming to the IIDC standard (V1.3 or V1.31) have created cost-effective and powerful solutions options being used for thousands of different applications around the world. **FireWire** is currently the premier robust digital interface for industrial applications for many reasons, including:

- Guaranteed bandwidth features to ensure fail-safe communications
- Interoperability with multiple different camera types and vendors
- Diverse camera powering options, including single-cable solutions up to 45 W
- Effective multiple-camera solutions
- Large variety of **FireWire** accessories for industrial applications
- Availability of repeaters and optical fibre cabling
- Forwards and backward compatibility blending 1394a and 1394b
- Both real-time (isochronous) and demand-driven asynchronous data transmission capabilities

FireWire in detail

Serial bus

Briefly summarized, **FireWire** is a very effective way to utilize a low-cost serial bus, through a standardized communications protocol, that establishes packetized data transfer between two or more devices. FireWire offers real time isochronous bandwidth for image transfer with guaranteed low latency. It also offers asynchronous data transfer for controlling camera parameters, such as gain and shutter, on the fly. As illustrated in the diagram below, these two modes can co-exist by using priority time slots for video data transfer and the remaining time slots for control data transfer.

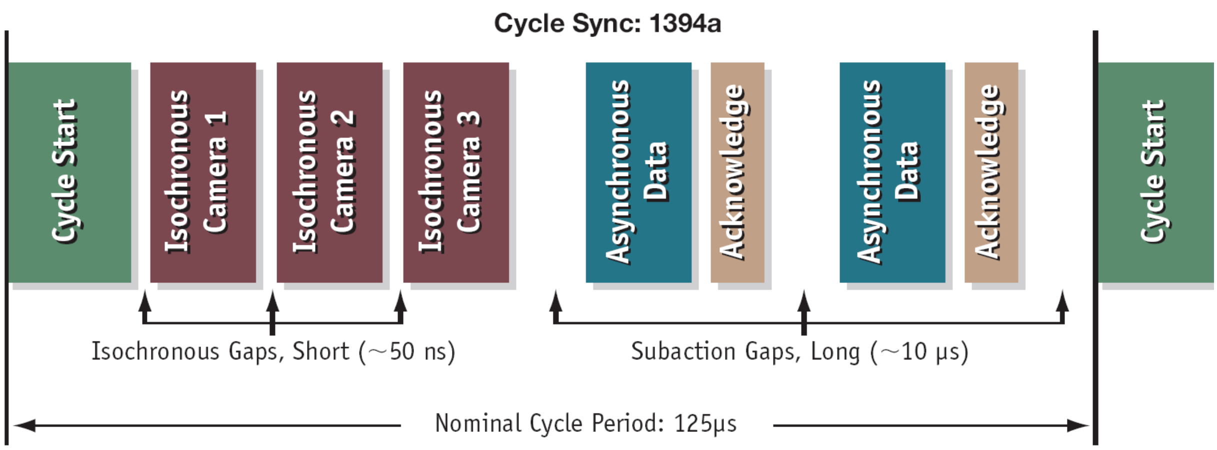


Figure 2: 1394a data transmission

In case of 1394b no gaps are needed due to parallel arbitration, handled by bus owner supervisor selector (BOSS) (see the following diagram). Whereas 1394a works in half duplex transmission, 1394 does full duplex transmission.

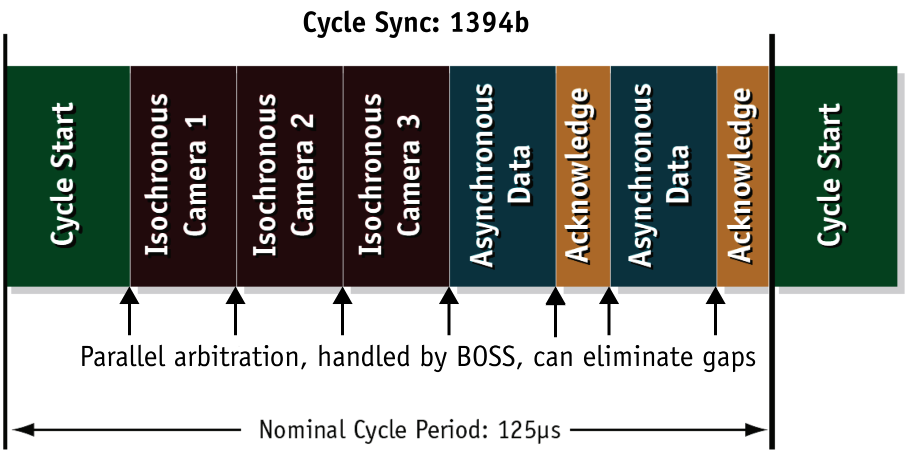


Figure 3: 1394b data transmission

Additional devices may be added up to the overall capacity of the bus, but throughput at guaranteed minimum service levels is maintained for all devices with an acknowledged claim on the bus. This deterministic feature is a huge advantage for many industrial applications where robust performance is required. Such is the case when it is not acceptable to drop images within a specific time interval.

FireWire connection capabilities

FireWire can connect together up to 63 peripherals in an acyclic network structure (hubs). It allows peer-to-peer device communication (between digital cameras), to take place without using system memory or the CPU.

But even more importantly, a **FireWire camera** can directly, via direct memory access (DMA), write into or read from the memory of the computer with almost no CPU load.

FireWire also supports multiple hosts per bus. **FireWire** requires only a cable with the correct number of pins on either end (normally 6 or 9). It is designed to support plug-and-play and hot swapping. Its six-wire cable can supply up to 54 W of power per port at 36 V, allowing moderate-consumption devices to operate without a separate power cord.

Capabilities of 1394a (FireWire 400)

FireWire 400 (S400) is able to transfer data between devices at 100, 200 or 400 MBit/s data rates. Although USB 2.0 claims to be capable of higher speeds (480 Mbit/s), FireWire is, in practice, not slower than USB 2.0.

The 1394a capabilities in detail:

- 400 Mbit/s
- Hot-pluggable devices
- Peer-to-peer communications
- Direct Memory Access (DMA) to host memory
- Guaranteed bandwidth
- Multiple devices (up to 45 W) powered via FireWire bus

IIDC V1.3 camera control standards

IIDC V1.3 released a set of camera control standards via 1394a which established a common communications protocol on which most current FireWire cameras are based.

In addition to common standards shared across manufacturers, a special Format_7 mode also provided a means by which a manufacturer could offer special features (smart features), such as:

- higher resolutions
- higher frame rates
- diverse color modes

as extensions (advanced registers) to the prescribed common set.

Capabilities of 1394b (FireWire 800)

FireWire 800 (S800) was introduced commercially by Apple in 2003 and has a 9-pin FireWire 800 connector (see details in Chapter IEEE 1394b port pin assignment on page 86). This newer 1394b specification allows a transfer rate of 800 MBit/s with backward compatibilities to the slower rates and 6-pin connectors of FireWire 400.

The 1394b capabilities in detail:

- 800 Mbit/s
- All previous benefits of 1394a (see above)
- Interoperability with 1394a devices
- Longer communications distances (up to 500 m using GOF cables)

IIDC V1.31 camera control standards

Twinned with 1394b, the IIDC V1.31 standard arrived in January 2004, evolving the industry standards for digital imaging communications to include I/O and RS232 handling, and adding further formats. At such high bandwidths it has become possible to transmit high-resolution images to the PC’s memory at very high frame rates.

Compatibility between 1394a and 1394b

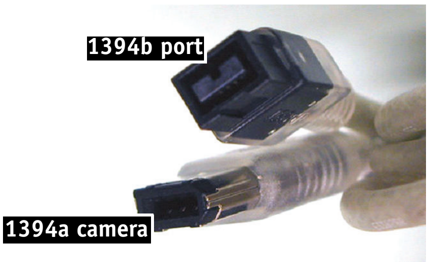
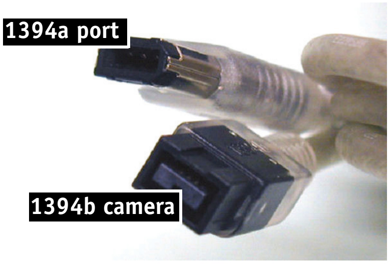
	
1394a camera connected to 1394b bus The cable explains dual compatibility: This cable serves to connect an IEEE 1394a camera with its **six-pin** connector to a bilingual port (a port which can talk in a- or b-language) of a 1394b bus. In this case the b-bus communicates in a-language and a-speed with the camera achieving a-performance	**1394b camera connected to 1394a bus** The cable explains dual compatibility: In this case, the cable connects an IEEE 1394b camera with its **nine-pin** connector to a 1394a port. In this case the b-camera communicates in a-language with the camera achieving a-performance

Figure 4: 1394a and 1394b cameras and compatibility

Compatibility example

It’s possible to run a 1394a and a 1394b camera on the 1394b bus.

You can e.g. run a PIKE F-032B and a MARLIN F-033B on the same bus:

- PIKE F-032B @ S800 and 120 fps (5120 bytes per cycle, 64% of the cycle slot)
- MARLIN F-033B @ S400 and 30 fps (1280bytes, 32% of the cycle slot)

Bus runs at 800 Mbit/s for all devices. Data from Marlin’s port is up-converted from 400 Mbit/s to 800 Mbit/s by data doubling (padding), still needing 32% of the cycle slot time. This doubles the bandwidth requirement for this port, as if the camera were running at 60 fps. Total consumption is thus 5120 + 2560 = 7680 bytes per cycle.

Image transfer via 1394a and 1394b

Technical detail	1394a	1394b
Transmission mode	Half duplex (both pairs needed) 400 Mbit/s data rate aka: a-mode, data/strobe (D/S) mode, legacy mode	Full duplex (one pair needed) 1 Gbit/s signaling rate, 800 Mbit/s data rate 10b/8b coding (Ethernet), aka: b-mode (beta mode)
Devices	Up to 63 devices per network	
Number of cameras	Up to 16 cameras per network	
Number of DMAs	4 to 8 DMAs (parallel) cameras / bus	
Real time capability	Image has real time priority	
Available bandwidth acc. IIDC (per cycle 125 µs)	4096 bytes per cycle ~ 1000q @ 400 Mbit/s	8192 bytes per cycle ~ 2000q @ 800 Mbit/s (@1 GHz clock rate)
	For further detail read Chapter Frame rates on page 216.	
Max. image bandwidth	31.25 MByte/s	62.5 MByte/s
Max. total bandwidth	~45 MByte/s	~85 MByte/s
Number of busses	Multiple busses per PC limit: PCI bus	Multiple busses per PC limit: PCI (Express) bus
CPU load	Almost none for DMA image transfer	
Gaps	Gaps negatively affect asynchronous performance of widespread network (round trip delay), reducing efficiency	No gaps needed, BOSS mode for parallel arbitration

Table 5: Technical detail comparison: 1394a and 1394b

Note

The bandwidth values refer to the fact:

1 MByte = 1024 kByte

1394b bandwidths

According to the 1394b specification on isochronous transfer, the largest data payload size of 8192 bytes per 125 µs cycle is possible with a bandwidth of 800 Mbit/s.

For further details read Chapter How does bandwidth affect the frame rate? on page 241.

Requirements for PC and 1394b

One PIKE camera connected to a PC’s 1394b bus saturates the standard PCI bus.

1394b also requires low latency for data transmission (due to small receive-FIFO). In order to get the most out of your camera-to-PC configuration, we recommend the following chipsets for your PC:

- For Intel-based desktops, chipset 945 (or higher)
- For non-Intel based desktops (e.g. AMD), PCI Express compatible chipset

www

For more information:

http://support.intel.com/support/chipsets/#desktop

For multi-camera applications one of the following bus cards is needed:

- PCI ExpressCard with potential 250 MByte/s per lane (up to four supported by chipset) or
- 64-bit PCI-X card (160 MByte/s)

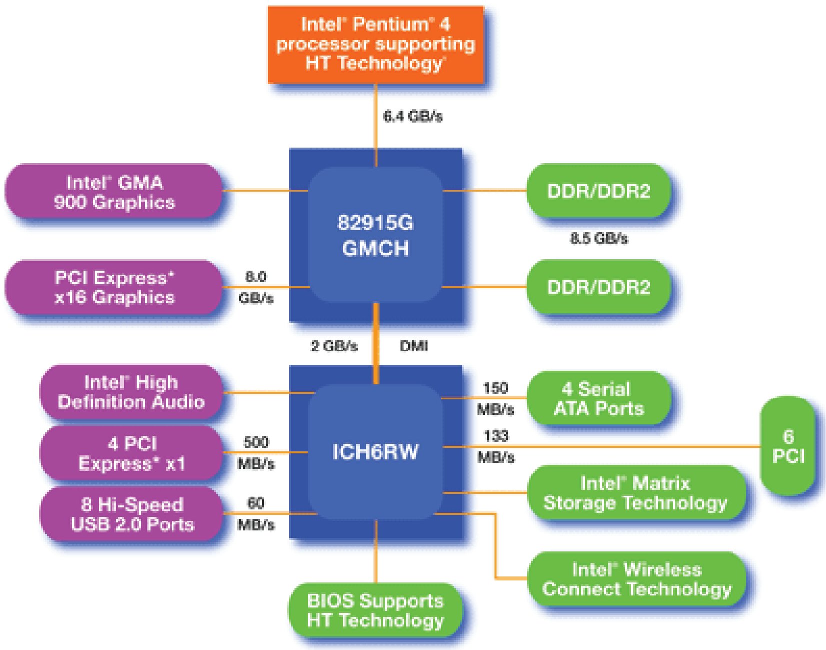


Figure 5: Block diagram of modern PC (915 chipset by INTEL)

Requirements for laptop and 1394b

As mentioned above, 1394b requires low latency for data transmission (small receive-FIFO). In order to get the most out of your camera-to-laptop configuration, we recommend the following chipset for your laptop:

- For Intel-based laptops, chipset 915 (or higher)
- For non-Intel based laptops (e.g. AMD), PCI Express compatible chipset

Because most laptops have (only) one PC-card interface, it is possible to connect one PIKE camera to your laptop at full speed. Alternatively laptops with an additional 1394 ExpressCard interface can be used.

Figure 6: ExpressCard Logo, ExpressCard/54 (SIIG)

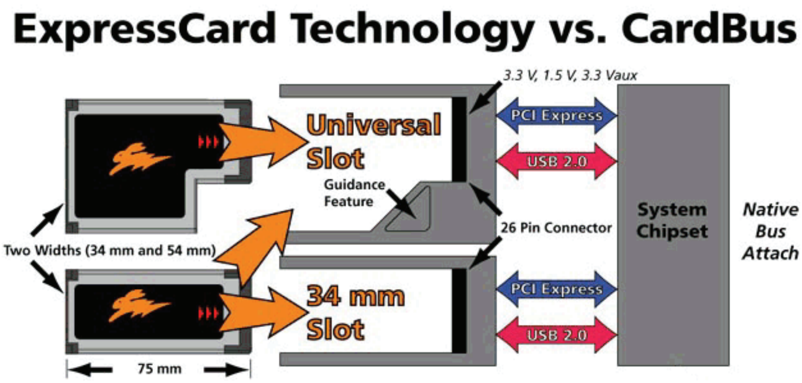


Figure 7: ExpressCard technology

www

ExpressCard is a new standard set by PCMCIA.

For more information visit:

http://www.expresscard.org/web/site/

Example1: 1394b bandwidth of PIKE cameras

PIKE model	Resolution	Frame rate	Bandwidth
Pike F-032 B/C	VGA	208 fps	62.5 MByte/s
Pike F-100 B/C	1 megapixel	60 fps	57.62 MByte/s
Pike F-145 B/C	1.45 megapixel	30 fps	41.41 MByte/s
Pike F-210 B/C	2.1 megapixel	31 fps	62.5 MByte/s
Pike F-421 B/C	4 megapixel	15 fps	62.5 MByte/s
Pike F-505 B/C	5 megapixel	13 fps	62.5 MByte/s

Table 6: Bandwidth of PIKE cameras

Note

All data are calculated using Raw8 / Mono8 color mode.

Example 2: More than one PIKE camera at full speed

Due to the fact that one PIKE camera saturates a 32 bit PCI bus, you are advised to use either a PCI Express card and/or multiple 64-bit PCI bus cards, if you want to use 2 or more PIKE cameras simultaneously (see the following table).

# cameras	PC hardware required
1 PIKE camera at full speed	1 x 32-bit PCI bus card (85 MByte/s)
2 or more PIKE cameras at full speed	PCI Express card and/or Multiple 64-bit PCI bus cards

Table 7: Required hardware for multiple camera applications

FireWire Plug & play capabilities

FireWire devices implement the ISO/IEC 13213 **configuration ROM** model for device configuration and identification, to provide plug & play capability. All FireWire devices are identified by an IEEE EUI-64 unique identifier (an extension of the 48-bit Ethernet MAC address format) in addition to well-known codes indicating the type of device and protocols it supports. For further details read Chapter Configuration of the camera on page 245.

FireWire hot plug precautions

Although FireWire devices can be hot-plugged without powering down equipment, we recommend turning the computer power off, before connecting a digital camera to it via a FireWire cable.

Operating system support

Operating system	1394a	1394b
Linux	Full support	Full support
Apple Mac OS X	Full support	Full support
Windows XP	With service pack 2 the default speed for 1394b is S100 (100 Mbit/s). A download and registry modification is available from Microsoft to restore performance to either S400 or S800. http://support.microsoft.com/kb/885222 Alternatively use the drivers of SP1 instead. We strongly recommend to install AVT FirePackage, which replaces the Microsoft driver. (See **PIKE Getting Started Manual** for details.)	
Windows Vista	Full support from beginning	Support only with service pack, coming later.

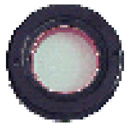
Table 8: FireWire and operating systems

System components

Each camera package consists of the following system components:

AVT PIKE

4.5 m cable with screw locking



Color version:
Jenofilt 217 IR cut filter (built-in)

B/w version:
only protection glass (no filter)

CD with driver and documentation

Optional: tripod adapter

Optional: GOF cable

Optional: HIROSE connector for cable mount HR10A-10P-12S

Figure 8: System components

The following illustration shows the spectral transmission of the IR cut filter:

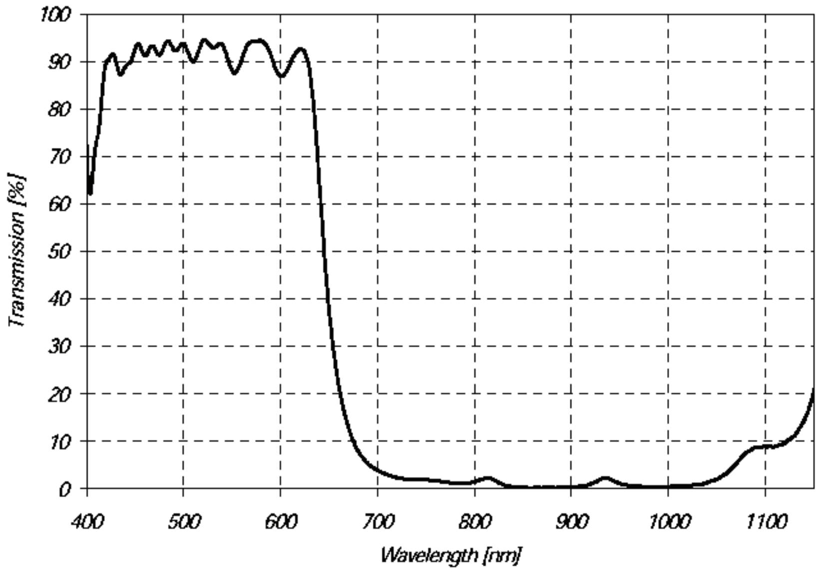


Figure 9: Spectral transmission of Jenofilt 217

Note

To demonstrate the properties of the camera, all examples in this manual are based on the **FirePackage** OHCI API software and the **SmartView** application.

www

These utilities can be obtained from Allied Vision Technologies (AVT). A free version of **SmartView** is available for download at:

www.alliedvisiontec.com

Note

The camera also works with all IIDC (formerly DCAM) compatible IEEE 1394 programs and image processing libraries.

Camera lenses

AVT offers different lenses from a variety of manufacturers. The following table lists selected image formats depending on camera type, distance and the focal length of the lens.

Focal length for type 1/3 sensors PIKE F-032	Distance = 0.5 m	Distance = 1 m
4.8 mm	0.375 m x 0.5 m	0.75 m x 1 m
8 mm	0.22 m x 0.29 m	0.44 m x 0.58 m
12 mm	0.145 m x 0.19 m	0.29 m x 0.38 m
16 mm	11 cm x 14.7 cm	22 cm x 29.4 cm
25 mm	6.9 cm x 9.2 cm	13.8 cm x 18.4 cm
35 mm	4.8 cm x 6.4 cm	9.6 cm x 12.8 cm
50 mm	3.3 cm x 4.4 cm	6.6 cm x 8.8 cm

Table 9: Focal length vs. field of view (PIKE F-032)

Focal length for type 2/3 sensors PIKE F-100/F-145/F-505	Distance = 0.5 m	Distance = 1 m
4.8 mm	0.7 m x0.93 m	1.4 m x 1.86 m
8 mm	0.4 m x 0.53 m	0.8 m x 1.06 m
12 mm	0.27 m x 0.36 m	0.54 m x 0.72 m
16 mm	0.2 m x 0.27 m	0.4 m x 0.54 m
25 mm	12.5 cm x 16.625 cm	25 cm 33.25 cm
35 mm	8.8 cm x 11.7 cm	17.6 cm x 23.4 cm
50 mm	6 cm x 7.98 cm	12 cm x 15.96 cm

Table 10: Focal length vs. field of view (PIKE F-100/F-145/F-505)

Focal length for type 1 sensors PIKE F-210	Distance = 0.5 m	Distance = 1 m
8 mm	0.6 m x 0.8 m	1.2 m x 1.6 m
12 mm	0.39 m x 0.52 m	0.78 m x 1.16 m
16 mm	0.29 m x 0.38 m	0.58 m x 0.76 m
25 mm	18.2 cm x 24.2 cm	36.4 cm x 48.8 cm
35 mm	12.8 cm x 17.02 cm	25.6 cm x 34.04 cm
50 mm	8.8 cm x 11.7 cm	17.6 cm x 23.4 cm

Table 11: Focal length vs. field of view (PIKE F-210)

Note

Lenses with focal lengths < 35 mm will very likely show excessive shading in the edges of the image due to the fact that the image size of the sensor is slightly bigger than the C-mount itself and due to micro lenses on the sensor's pixel.

Ask your dealer if you require non C-Mount lenses.

Focal length for type 1.2 sensors PIKE F-421	Distance = 0.5 m	Distance = 1 m
35 mm	15.4 cm x 20.4 cm	30.7 cm x 40.8 cm
50 mm	10.6 cm x 14.0 cm	21.1 cm x 28.1 cm

Table 12: Focal length vs. field of view (PIKE F-421)

Specifications

Note

H-binning means horizontal binning.

V-binning means vertical binning.

H-sub-sampling means horizontal sub-sampling.

V-sub-sampling means vertical sub-sampling.

PIKE F-032B / F-032B fiber

Feature	Specification
Image device	Type 1/3 (diag. 5.92 mm) type progressive scan KODAK IT CCD KAI340
Lens mount	Adjustable C-Mount: 17.526 mm (in air); Ø 25.4 mm (32 tpi) mechanical flange back to filter distance: 12.5 mm (see Figure 34: Pike C-Mount dimensions (VGA size filter for Pike F-032) on page 79) Adjustable CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 7.9 mm (see Figure 33: Pike CS-Mount dimensions (only PIKE F-032B/C) on page 78)
Picture sizes (default modes)	640 x 480 pixels (Format_0 Mode_5 and Mode_6) 640 x 480 pixels (Format_7 Mode_0) 320 x 480 pixels (Format_7 Mode_1, 2 x H-binning) 640 x 240 pixels (Format_7 Mode_2, 2 x V-binning) 320 x 240 pixels (Format_7 Mode_3, 2 x full binning) 320 x 480 pixels (Format_7 Mode_4, 2 out of 4 H-sub-sampling) 640 x 240 pixels (Format_7 Mode_5, 2 out of 4 V-sub-sampling) 320 x 240 pixels (Format_7 Mode_6, 2 out of 4 full sub-sampling)
Cell size	7.4 µm x 7.4 µm
ADC	14 bit
Frame rates	1.875 fps; 3.75 fps; 7.5 fps; 15 fps; 30 fps; 60 fps; 120 fps up to 208 fps in Format_7 (Mono8)
Gain control	Manual: 0-22 dB (0.0353 dB/step); auto gain (select. AOI)
Shutter speed	**18** … 67.108.864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Programmable, trigger level control, single trigger, bulk trigger, programmable trigger delay
Internal FIFO memory	Up to 105 frames
# look-up tables	4 user programmable (14 bit → 14 bit); gamma (0.45 and 0.7)
Smart functions	AGC (auto gain control), AEC (auto exposure control), real-time shading correction, LUT, 64 MByte image memory, mirror, binning, sub-sampling, High SNR, storable user sets Two configurable inputs, four configurable outputs RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s, 800 Mbit/s

Table 13: Specification PIKE F-032B / F-032B fiber

Feature	Specification
Digital interface	IEEE 1394b (IIDC V1.31), 2 x copper connectors (bilingual) (daisy chain) **fiber**: IEEE 1394b, 2 connectors: 1 x copper (bilingual), 1 x GOF connector (2 x optical fiber on LCLC), (daisy chain)
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 12-pin HIROSE
Power consumption	Typical 5 watt (@ 12 V DC); **fiber:** typical 5.75 watt (@ 12 V DC) (full resolution and maximal frame rates)
Dimensions	96.8 mm x 44 mm x 44 mm (L x W x H); incl. connectors, w/o tripod and lens
Mass	250 g (without lens)
Operating temperature	+ 5 °C ... + 50 °C housing temperature (without condensation)
Storage temperature	- 10 °C ... + 60 °C ambient temperature (without condensation)
Regulations	EN 55022, EN 61000, EN 55024, FCC Class B, DIN ISO 9022, RoHS (2002/95/EC)
Options	IR cut filter, IR pass filter, host adapter card, angled head, power out (HIROSE), API (FirePackage, Direct FirePackage, Fire4Linux)

Table 13: Specification PIKE F-032B / F-032B fiber

Note

The design and specifications for the products described above may change without notice.

PIKE F-032C / F-032C fiber

Feature	Specification
Image device	Type 1/3 (diag. 5.92 mm) type progressive scan KODAK IT CCD KAI340
Lens mount	Adjustable C-Mount: 17.526 mm (in air); Ø 25.4 mm (32 tpi) mechanical flange back to filter distance: 12.5 mm (see Figure 34: Pike C-Mount dimensions (VGA size filter for Pike F-032) on page 79) Adjustable CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 7.9 mm (see Figure 33: Pike CS-Mount dimensions (only PIKE F-032B/C) on page 78)
Picture sizes (default modes)	320 x 240 pixels (Format_0 Mode_1) 640 x 480 pixels (Format_0 Mode_2 to Mode_5) 640 x 480 pixels (Format_7 Mode_0) 320 x 480 pixels (Format_7 Mode_4, 2 out of 4 H-sub-sampling) 640 x 240 pixels (Format_7 Mode_5, 2 out of 4 V-sub-sampling) 320 x 240 pixels (Format_7 Mode_6, 2 out of 4 full sub-sampling)
Cell size	7.4 µm x 7.4 µm
ADC	14 bit
Color modes	Raw8, Raw12, Raw16, Mono8, YUV4:2:2, YUV4:1:1, RGB8
Frame rates	1.875 fps; 3.75 fps; 7.5 fps; 15 fps; 30 fps; 60 fps; 120 fps up to 208 fps in Format_7 (Mono8, Raw8) up to 139 fps in Format_7 (Raw12) up to 139 fps (YUV 4:1:1) up to 105 fps (YUV 4:2:2, Raw 16) up to 70 fps (RGB8)
Gain control	Manual: 0-20 dB (0.0353 dB/step); auto gain (select. AOI)
Shutter speed	**18** … 67.108.864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Programmable, trigger level control, single trigger, bulk trigger, programmable trigger delay
Internal FIFO memory	Up to 105 frames
# look-up tables	4 user programmable (14 bit → 14 bit); gamma (0.45 and 0.7)

Table 14: Specification PIKE F-032C / F-032C fiber

Feature	Specification
Smart functions	AGC (auto gain control), AEC (auto exposure control), AWB (auto white balance), color correction, hue, saturation, real-time shading correction, LUT, 64 MByte image memory, mirror, sub-sampling, High SNR, storable user sets Two configurable inputs, four configurable outputs RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s, 800 Mbit/s
Digital interface	IEEE 1394b (IIDC V1.31), 2 x copper connectors (bilingual) (daisy chain) **fiber**: IEEE 1394b, 2 connectors: 1 x copper (bilingual), 1 x GOF connector (2 x optical fiber on LCLC), (daisy chain)
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 12-pin HIROSE
Power consumption	Typical 5 watt (@ 12 V DC); **fiber:** typical 5.75 watt (@ 12 V DC) (full resolution and maximal frame rates)
Dimensions	96.8 mm x 44 mm x 44 mm (L x W x H); incl. connectors, w/o tripod and lens
Mass	250 g (without lens)
Operating temperature	+ 5 °C ... + 50 °C housing temperature (without condensation)
Storage temperature	- 10 °C ... + 60 °C ambient temperature (without condensation)
Regulations	EN 55022, EN 61000, EN 55024, FCC Class B, DIN ISO 9022, RoHS (2002/95/EC)
Options	Protection glass, host adapter card, angled head, power out (HIROSE), API (FirePackage, Direct FirePackage, Fire4Linux)

Table 14: Specification PIKE F-032C / F-032C fiber

Note

The design and specifications for the products described above may change without notice.

PIKE F-100B / F-100B fiber

Feature	Specification
Image device	Type 2/3 (diag. 10.5 mm) type progressive scan KODAK IT CCD KAI1020
Lens mount	Adjustable C-Mount: 17.526 mm (in air); Ø 25.4 mm (32 tpi) mechanical flange back to filter distance: 12.5 mm (see Figure 35: Pike C-Mount dimensions (large filter for Pike F-100, F-145, F-210, F-421, F-505) on page 80)
Picture sizes (default modes)	640 x 480 pixels (Format_0 Mode_5 and Mode_6) 800 x 600 pixels (Format_1 Mode_2 and Mode_6) 1000 x 1000 pixels (Format_7 Mode_0) 500 x 1000 pixels (Format_7 Mode_1, 2 x H-binning) 1000 x 500 pixels (Format_7 Mode_2, 2 x V-binning) 500 x 500 pixels (Format_7 Mode_3, 2 x full binning) 500 x 1000 pixels (Format_7 Mode_4, 2 out of 4 H-sub-sampling) 1000 x 500 pixels (Format_7 Mode_5, 2 out of 4 V-sub-sampling) 500 x 500 pixels (Format_7 Mode_6, 2 out of 4 full sub-sampling)
Cell size	7.4 µm x 7.4 µm
ADC	14 bit
Frame rates	1.875 fps; 3.75 fps; 7.5 fps; 15 fps; 30 fps; 60 fps up to 60 fps in Format_7 (Mono8)
Gain control	Manual: 0-22 dB (0.0353 dB/step); auto gain (select. AOI)
Shutter speed	**43** µs … 67.108.864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Programmable, trigger level control, single trigger, bulk trigger, programmable trigger delay
Internal FIFO memory	Up to 32 frames
# look-up tables	4 user programmable (14 bit → 14 bit); gamma (0.45 and 0.7)
Smart functions	AGC (auto gain control), AEC (auto exposure control), real-time shading correction, LUT, 64 MByte image memory, mirror, binning, sub-sampling, High SNR, storable user sets Two configurable inputs, four configurable outputs RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s, 800 Mbit/s
Digital interface	IEEE 1394b (IIDC V1.31), 2 x copper connectors (bilingual) (daisy chain) **fiber**: IEEE 1394b, 2 connectors: 1 x copper (bilingual), 1 x GOF connector (2 x optical fiber on LCLC), (daisy chain)

Table 15: Specification PIKE F-100B / F-100B fiber

Feature	Specification
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 12-pin HIROSE
Power consumption	Typical 5 watt (@ 12 V DC); **fiber:** typical 5.75 watt (@ 12 V DC)
Dimensions	96.8 mm x 44 mm x 44 mm (L x W x H); incl. connectors, w/o tripod and lens
Mass	250 g (without lens)
Operating temperature	+ 5 °C ... + 50 °C housing temperature (without condensation)
Storage temperature	- 10 °C ... + 60 °C ambient temperature (without condensation)
Regulations	EN 55022, EN 61000, EN 55024, FCC Class B, DIN ISO 9022, RoHS (2002/95/EC)
Options	IR cut filter, IR pass filter, host adapter card, angled head, power out (HIROSE), API (FirePackage, Direct FirePackage, Fire4Linux)

Table 15: Specification PIKE F-100B / F-100B fiber

Note

The design and specifications for the products described above may change without notice.

PIKE F-100C / F-100C fiber

Feature	Specification
Image device	Type 2/3 (diag. 10.5 mm) type progressive scan KODAK IT CCD KAI1020
Lens mount	Adjustable C-Mount: 17.526 mm (in air); Ø 25.4 mm (32 tpi) mechanical flange back to filter distance: 12.5 mm (see Figure 35: Pike C-Mount dimensions (large filter for Pike F-100, F-145, F-210, F-421, F-505) on page 80)
Picture sizes (default modes)	320 x 240 pixels (Format_0 Mode_1) 640 x 480 pixels (Format_0 Mode_2 to Mode_5) 800 x 600 pixels (Format_1 Mode_0 to Mode_2) 1000 x 1000 pixels (Format_7 Mode_0) 500 x 1000 pixels (Format_7 Mode_4, 2 out of 4 H-sub-sampling) 1000 x 500 pixels (Format_7 Mode_5, 2 out of 4 V-sub-sampling) 500 x 500 pixels (Format_7 Mode_6, 2 out of 4 full sub-sampling)
Cell size	7.4 µm x 7.4 µm
ADC	14 bit
Color modes	Raw8, Raw12, Raw16, Mono8, YUV4:2:2, YUV4:1:1, RGB8
Frame rates	1.875 fps; 3.75 fps; 7.5 fps; 15 fps; 30 fps; 60 fps; 120 fps up to 60 fps in Format_7 (Mono8, Raw8) up to 43 fps in Format_7 (Raw12) up to 43 fps (YUV 4:1:1) up to 33 fps (YUV 4:2:2, Raw16) up to 22 fps (RGB8)
Gain control	Manual: 0-20 dB (0.0353 dB/step); auto gain (select. AOI)
Shutter speed	**43** µs … 67.108.864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Programmable, trigger level control, single trigger, bulk trigger, programmable trigger delay
Internal FIFO memory	Up to 32 frames
# look-up tables	4 user programmable (14 bit → 14 bit); gamma (0.45 and 0.7)
Smart functions	AGC (auto gain control), AEC (auto exposure control), AWB (auto white balance), color correction, hue, saturation, real-time shading correction, LUT, 64 MByte image memory, mirror, sub-sampling, High SNR, storable user sets Two configurable inputs, four configurable outputs RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s, 800 Mbit/s

Table 16: Specification PIKE F-100C / F-100C fiber

Feature	Specification
Digital interface	IEEE 1394b (IIDC V1.31), 2 x copper connectors (bilingual) (daisy chain) **fiber**: IEEE 1394b, 2 connectors: 1 x copper (bilingual), 1 x GOF connector (2 x optical fiber on LCLC), (daisy chain)
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 12-pin HIROSE
Power consumption	Typical 5 watt (@ 12 V DC); **fiber:** typical 5.75 watt (@ 12 V DC)
Dimensions	96.8 mm x 44 mm x 44 mm (L x W x H); incl. connectors, w/o tripod and lens
Mass	250 g (without lens)
Operating temperature	+ 5 °C ... + 50 °C housing temperature (without condensation)
Storage temperature	- 10 °C ... + 60 °C ambient temperature (without condensation)
Regulations	EN 55022, EN 61000, EN 55024, FCC Class B, DIN ISO 9022, RoHS (2002/95/EC)
Options	Protection glass, host adapter card, angled head, power out (HIROSE), API (FirePackage, Direct FirePackage, Fire4Linux)

Table 16: Specification PIKE F-100C / F-100C fiber

Note

The design and specifications for the products described above may change without notice.

PIKE F-145B / F-145B fiber (-15fps*)

* Variant: F-145-15fps only

This variant offers lower speed (only 15 fps), but better image quality.

Feature	Specification
Image device	Type 2/3 (diag. 11.2 mm) type progressive scan SONY ICX285
Lens mount	Adjustable C-Mount: 17.526 mm (in air); Ø 25.4 mm (32 tpi) mechanical flange back to filter distance: 12.5 mm (see Figure 35: Pike C-Mount dimensions (large filter for Pike F-100, F-145, F-210, F-421, F-505) on page 80)
Picture sizes (default modes)	640 x 480 pixels (Format_0 Mode_5 and Mode_6) 800 x 600 pixels (Format_1 Mode_2 and Mode_6) 1024 x 768 pixels (Format_1 Mode_5 and Mode_7) 1280 x 960 pixels (Format_2 Mode_2 and Mode_6) 1388 x 1038 pixels (Format_7 Mode_0) 692 x 1038 pixels (Format_7 Mode_1, 2 x H-binning) 1388 x 518 pixels (Format_7 Mode_2, 2 x V-binning) 692 x 518 pixels (Format_7 Mode_3, 2 x full binning) 692 x 1038 pixels (Format_7 Mode_4, 2 out of 4 H-sub-sampling) 1388 x 518 pixels (Format_7 Mode_5, 2 out of 4 V-sub-sampling) 692 x 518 pixels (Format_7 Mode_6, 2 out of 4 full sub-sampling)
Cell size	6.45 µm x 6.45 µm
ADC	14 bit
Frame rates	1.875 fps; 3.75 fps; 7.5 fps; 15 fps; 30 fps (* Variant: F-145-15fps only up to 15 fps) up to 30 (16*) fps in Format_7 (Mono8 no sub-sampling) up to 30 (16*) fps in Format_7 (Mono12 no sub-sampling) up to 23 (16*) fps in Format_7 (Mono16 no sub-sampling)
Gain control	Manual: 0-32 dB (0.0358 dB/step); auto gain (select. AOI)
Shutter speed	**39 (71*)** µs … 67.108.864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Programmable, trigger level control, single trigger, bulk trigger, programmable trigger delay
Internal FIFO memory	Up to 22 frames
# look-up tables	4 user programmable (14 bit → 14 bit); gamma (0.45 and 0.7)

Table 17: Specification PIKE F-145B / F-145B fiber

Feature	Specification
Smart functions	AGC (auto gain control), AEC (auto exposure control), real-time shading correction, LUT, 64 MByte image memory, mirror, binning, sub-sampling, High SNR, storable user sets Two configurable inputs, four configurable outputs RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s, 800 Mbit/s
Digital interface	IEEE 1394b (IIDC V1.31), 2 x copper connectors (bilingual) (daisy chain) **fiber**: IEEE 1394b, 2 connectors: 1 x copper (bilingual), 1 x GOF connector (2 x optical fiber on LCLC), (daisy chain)
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 12-pin HIROSE
Power consumption	Typical 5 watt (@ 12 V DC); **fiber:** typical 5.75 watt (@ 12 V DC)
Dimensions	96.8 mm x 44 mm x 44 mm (L x W x H); incl. connectors, w/o tripod and lens
Mass	250 g (without lens)
Operating temperature	+ 5 °C ... + 50 °C housing temperature (without condensation)
Storage temperature	- 10 °C ... + 60 °C ambient temperature (without condensation)
Regulations	EN 55022, EN 61000, EN 55024, FCC Class B, DIN ISO 9022, RoHS (2002/95/EC)
Options	IR cut filter, IR pass filter, host adapter card, angled head, power out (HIROSE), API (FirePackage, Direct FirePackage, Fire4Linux)

Table 17: Specification PIKE F-145B / F-145B fiber

Note

The design and specifications for the products described above may change without notice.

PIKE F-145C / F-145C fiber (-15fps*)

* Variant: F-145-15fps only

This variant offers lower speed (only 15 fps), but better image quality.

Feature	Specification
Image device	Type 2/3 (diag. 11.2 mm) type progressive scan SONY ICX285
Lens mount	Adjustable C-Mount: 17.526 mm (in air); Ø 25.4 mm (32 tpi) mechanical flange back to filter distance: 12.5 mm (see Figure 35: Pike C-Mount dimensions (large filter for Pike F-100, F-145, F-210, F-421, F-505) on page 80)
Picture sizes (default modes)	320 x 240 pixels (Format_0 Mode_1) 640 x 480 pixels (Format_0 Mode_2 to Mode_5) 800 x 600 pixels (Format_1 Mode_0 to Mode_2) 1024 x 768 pixels (Format_1 Mode_3 to Mode_5) 1280 x 960 pixels (Format_2 Mode_0 to Mode_2) 1388 x 1038 pixels (Format_7 Mode_0) 692 x 1038 pixels (Format_7 Mode_4, 2 out of 4 H-sub-sampling) 1388 x 518 pixels (Format_7 Mode_5, 2 out of 4 V-sub-sampling) 692 x 518 pixels (Format_7 Mode_6, 2 out of 4 full sub-sampling)
Cell size	6.45 µm x 6.45 µm
ADC	14 bit
Color modes	Raw8, Raw12, Raw16, Mono8, YUV4:2:2, YUV4:1:1, RGB8
Frame rates	1.875 fps; 3.75 fps; 7.5 fps; 15 fps; 30 fps; 60 fps up to 30 (16*) fps in Format_7 (Mono8, Raw8, no sub-sampling) up to 30 (16*) fps in Format_7 (Raw12, no sub-sampling) up to 30 (16*) fps (YUV 4:1:1, no sub-sampling) up to 23 (16) fps (YUV 4:2:2, Raw16, no sub-sampling) up to 15 (15*) fps (RGB8, no sub-sampling)
Gain control	Manual: 0-32 dB (0.0358 dB/step); auto gain (select. AOI)
Shutter speed	**39 (71*)** µs … 67.108.864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Programmable, trigger level control, single trigger, bulk trigger, programmable trigger delay
Internal FIFO memory	Up to 22 frames
# look-up tables	4 user programmable (14 bit → 14 bit); gamma (0.45 and 0.7)

Table 18: Specification PIKE F-145C / F-145C fiber

Feature	Specification
Smart functions	AGC (auto gain control), AEC (auto exposure control), AWB (auto white balance), color correction, hue, saturation, real-time shading correction, LUT, 64 MByte image memory, mirror, sub-sampling, High SNR, storable user sets Two configurable inputs, four configurable outputs RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s, 800 Mbit/s
Digital interface	IEEE 1394b (IIDC V1.31), 2 x copper connectors (bilingual) (daisy chain) **fiber**: IEEE 1394b, 2 connectors: 1 x copper (bilingual), 1 x GOF connector (2 x optical fiber on LCLC), (daisy chain)
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 12-pin HIROSE
Power consumption	Typical 5 watt (@ 12 V DC); **fiber:** typical 5.75 watt (@ 12 V DC)
Dimensions	96.8 mm x 44 mm x 44 mm (L x W x H); incl. connectors, w/o tripod and lens
Mass	250 g (without lens)
Operating temperature	+ 5 °C ... + 50 °C housing temperature (without condensation)
Storage temperature	- 10 °C ... + 60 °C ambient temperature (without condensation)
Regulations	EN 55022, EN 61000, EN 55024, FCC Class B, DIN ISO 9022, RoHS (2002/95/EC)
Options	Protection glass, host adapter card, angled head, power out (HIROSE), API (FirePackage, Direct FirePackage, Fire4Linux)

Table 18: Specification PIKE F-145C / F-145C fiber

Note

The design and specifications for the products described above may change without notice.

PIKE F-210B / F210B fiber

Feature	Specification
Image device	Type 1 (diag. 15.3 mm) type progressive scan KODAK IT CCD KAI2093
Lens mount	Adjustable C-Mount: 17.526 mm (in air); Ø 25.4 mm (32 tpi) mechanical flange back to filter distance: 12.5 mm (see Figure 35: Pike C-Mount dimensions (large filter for Pike F-100, F-145, F-210, F-421, F-505) on page 80)
Picture sizes (default modes)	640 x 480 pixels (Format_0 Mode_5 and Mode_6) 800 x 600 pixels (Format_1 Mode_2 and Mode_6) 1024 x 768 pixels (Format_1 Mode_5 and Mode_7) 1280 x 960 pixels (Format_2 Mode_2 and Mode_6) 1600 x 1200 pixels (Format_2 Mode_5 and Mode_7) 1920 x 1080 pixels (Format_7 Mode_0) 960 x 1080 pixels (Format_7 Mode_1, 2 x H-binning) 1920 x 540 pixels (Format_7 Mode_2, 2 x V-binning) 960 x 540 pixels (Format_7 Mode_3, 2 x full binning) 960 x 1080 pixels (Format_7 Mode_4, 2 out of 4 H-sub-sampling) 1920 x 540 pixels (Format_7 Mode_5, 2 out of 4 V-sub-sampling) 960 x 540 pixels (Format_7 Mode_6, 2 out of 4 full sub-sampling)
Cell size	7.4 µm x 7.4 µm
ADC	14 bit
Frame rates	1.875 fps; 3.75 fps; 7.5 fps; 15 fps; 30 fps up to 31 fps in Format_7 (Mono8, no sub-sampling)
Gain control	Manual: 0-22 dB (0.0353 dB/step); auto gain (select. AOI)
Shutter speed	**43** … 67.108.864 µs (~67s); auto shutter (select. AOI)
External Trigger Shutter	Programmable, trigger level control, single trigger, bulk trigger, programmable trigger delay
Internal FIFO memory	Up to 15 frames
# look-up tables	4 user programmable (14 bit → 14 bit); gamma (0.45 and 0.7)
Smart functions	AGC (auto gain control), AEC (auto exposure control), real-time shading correction, LUT, 64 MByte image memory, mirror, binning, sub-sampling, High SNR, storable user sets Two configurable inputs, four configurable outputs RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s, 800 Mbit/s

Table 19: Specification PIKE F-210B / F-210B fiber

Feature	Specification
Digital interface	IEEE 1394b (IIDC V1.31), 2 x copper connectors (bilingual) (daisy chain) **fiber**: IEEE 1394b, 2 connectors: 1 x copper (bilingual), 1 x GOF connector (2 x optical fiber on LCLC), (daisy chain)
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 12-pin HIROSE
Power consumption	Typical 5.5 watt (@ 12 V DC); **fiber:** typical 6.25 watt (@ 12 V DC)
Dimensions	96.8 mm x 44 mm x 44 mm (L x W x H); incl. connectors, w/o tripod and lens
Mass	250 g (without lens)
Operating temperature	+ 5 °C ... + 50 °C housing temperature (without condensation)
Storage temperature	- 10 °C ... + 60 °C ambient temperature (without condensation)
Regulations	EN 55022, EN 61000, EN 55024, FCC Class B, DIN ISO 9022, RoHS (2002/95/EC)
Options	IR cut filter, IR pass filter M39-Mount suitable for e.g. Voigtländer optics Adjustable M39-Mount: 28.80 mm (in air); M39 x 26 tpi mechanical flange back to filter distance: 24.2 mm (see Figure 37: Pike M39-Mount dimensions (only Pike F-210 and Pike F-421) on page 82) host adapter card, angled head, power out (HIROSE), API (FirePackage, Direct FirePackage, Fire4Linux)

Table 19: Specification PIKE F-210B / F-210B fiber

Note

The design and specifications for the products described above may change without notice.

PIKE F-210C / F-210C fiber

Feature	Specification
Image device	Type 1 (diag. 15.3 mm) type progressive scan KODAK IT CCD KAI2093
Lens mount	Adjustable C-Mount: 17.526 mm (in air); Ø 25.4 mm (32 tpi) mechanical flange back to filter distance: 12.5 mm (see Figure 35: Pike C-Mount dimensions (large filter for Pike F-100, F-145, F-210, F-421, F-505) on page 80)
Picture sizes (default modes)	320 x 240 pixels (Format_0 Mode_1) 640 x 480 pixels (Format_0 Mode_2 to Mode_5) 800 x 600 pixels (Format_1 Mode_0 to Mode_2) 1024 x 768 pixels (Format_1 Mode_3 to Mode_5) 1280 x 960 pixels (Format_2 Mode_0 to Mode_2) 1600 x 1200 pixels (Format_2 Mode_3 to Mode_5) 1920 x 1080 pixels (Format_7 Mode_0) 960 x 1080 pixels (Format_7 Mode_4, 2 out of 4 H-sub-sampling) 1920 x 540 pixels (Format_7 Mode_5, 2 out of 4 V-sub-sampling) 960 x 540 pixels (Format_7 Mode_6, 2 out of 4 full sub-sampling)
Cell size	7.4 µm x 7.4 µm
ADC	14 bit
Color modes	Raw8, Raw12, Raw16, Mono8, YUV4:2:2, YUV4:1:1, RGB8
Frame rates	1.875 fps; 3.75 fps; 7.5 fps; 15 fps; 30 fps; 60 fps up to 40 fps (Mono8, Raw8, no sub-sampling) up to 40 fps (Raw12, no sub-sampling) up to 40 fps (YUV 4:1:1, no sub-sampling) up to 31 fps (YUV 4:2:2, Raw16, no sub-sampling) up to 21 fps (RGB8, no sub-sampling)
Gain control	Manual: 0-20 dB (0.0353 dB/step); auto gain (select. AOI)
Shutter speed	**43** … 67.108.864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Programmable, trigger level control, single trigger, bulk trigger, programmable trigger delay
Internal FIFO memory	Up to 15 frames
# look-up tables	4 user programmable (14 bit → 14 bit); gamma (0.45 and 0.7)

Table 20: Specification PIKE F-210C / F-210C fiber

Feature	Specification
Smart functions	AGC (auto gain control), AEC (auto exposure control), AWB (auto white balance), color correction, hue, saturation, real-time shading correction, LUT, 64 MByte image memory, mirror, sub-sampling, High SNR, storable user sets Two configurable inputs, four configurable outputs RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s, 800 Mbit/s
Digital interface	IEEE 1394b (IIDC V1.31), 2 x copper connectors (bilingual) (daisy chain) **fiber**: IEEE 1394b, 2 connectors: 1 x copper (bilingual), 1 x GOF connector (2 x optical fiber on LCLC), (daisy chain)
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 12-pin HIROSE
Power consumption	Typical 5.5 watt (@ 12 V DC); **fiber:** typical 6.25 watt (@ 12 V DC)
Dimensions	96.8 mm x 44 mm x 44 mm (L x W x H); incl. connectors, w/o tripod and lens
Mass	250 g (without lens)
Operating temperature	+ 5 °C ... + 50 °C housing temperature (without condensation)
Storage temperature	- 10 °C ... + 60 °C ambient temperature (without condensation)
Regulations	EN 55022, EN 61000, EN 55024, FCC Class B, DIN ISO 9022, RoHS (2002/95/EC)
Options	Protection glass M39-Mount suitable for e.g. Voigtländer optics Adjustable M39-Mount: 28.80 mm (in air); M39 x 26 tpi mechanical flange back to filter distance: 24.2 mm (see Figure 37: Pike M39-Mount dimensions (only Pike F-210 and Pike F-421) on page 82) host adapter card, angled head, power out (HIROSE), API (FirePackage, Direct FirePackage, Fire4Linux)

Table 20: Specification PIKE F-210C / F-210C fiber

Note

The design and specifications for the products described above may change without notice.

PIKE F-421B / F-421B fiber

Feature	Specification
Image device	Type 1.2 (diag. 21.4 mm) type progressive scan KODAK IT CCD KAI4021
Lens mount	Adjustable C-Mount: 17.526 mm (in air); Ø 25.4 mm (32 tpi) mechanical flange back to filter distance: 12.5 mm (see Figure 35: Pike C-Mount dimensions (large filter for Pike F-100, F-145, F-210, F-421, F-505) on page 80)
Picture sizes (default modes)	640 x 480 pixels (Format_0 Mode_5 and Mode_6) 800 x 600 pixels (Format_1 Mode_2 and Mode_6) 1024 x 768 pixels (Format_1 Mode_5 and Mode_7) 1280 x 960 pixels (Format_2 Mode_2 and Mode_6) 1600 x 1200 pixels (Format_2 Mode_5 and Mode_7) 2048 x 2048 pixels (Format_7 Mode_0) 1024 x 2048 pixels (Format_7 Mode_1, 2 x H-binning) 2048 x 1024 pixels (Format_7 Mode_2, 2 x V-binning) 1024 x 1024 pixels (Format_7 Mode_3, 2 x full binning) 1024 x 2048 pixels (Format_7 Mode_4, 2 out of 4 H-sub-sampling) 2048 x 1024 pixels (Format_7 Mode_5, 2 out of 4 V-sub-sampling) 1024 x 1024 pixels (Format_7 Mode_6, 4 out of 4 full sub-sampling)
Cell size	7.4 µm x 7.4 µm
ADC	14 bit
Frame rates	1.875 fps; 3.75 fps; 7.5 fps; 15 fps; 30 fps up to 16 fps in Format_7 (Mono8)
Gain control	Manual: 0-22 dB (0.0353 dB/step); auto gain (select. AOI)
Shutter speed	**70** … 67.108.864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Programmable, trigger level control, single trigger, bulk trigger, programmable trigger delay
Internal FIFO memory	Up to 6 frames
# look-up tables	4 user programmable (14 bit → 14 bit); gamma (0.45 and 0.7)
Smart functions	AGC (auto gain control), AEC (auto exposure control), real-time shading correction, LUT, 64 MByte image memory, mirror, binning, sub-sampling, High SNR, storable user sets Two configurable inputs, four configurable outputs RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s, 800 Mbit/s

Table 21: Specification PIKE F-421B / F-421B fiber

Feature	Specification
Digital interface	IEEE 1394b (IIDC V1.31), 2 x copper connectors (bilingual) (daisy chain) **fiber**: IEEE 1394b, 2 connectors: 1 x copper (bilingual), 1 x GOF connector (2 x optical fiber on LCLC), (daisy chain)
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 12-pin HIROSE
Power consumption	Typical 5.5 watt (@ 12 V DC); **fiber:** typical 6.25 watt (@ 12 V DC)
Dimensions	96.8 mm x 44 mm x 44 mm (L x W x H); incl. connectors, w/o tripod and lens
Mass	250 g (without lens)
Operating temperature	+ 5 °C ... + 50 °C housing temperature (without condensation)
Storage temperature	- 10 °C ... + 60 °C ambient temperature (without condensation)
Regulations	EN 55022, EN 61000, EN 55024, FCC Class B, DIN ISO 9022, RoHS (2002/95/EC)
Options	IR cut filter, IR pass filter M39-Mount suitable for e.g. Voigtländer optics Adjustable M39-Mount: 28.80 mm (in air); M39 x 26 tpi mechanical flange back to filter distance: 24.2 mm (see Figure 37: Pike M39-Mount dimensions (only Pike F-210 and Pike F-421) on page 82) host adapter card, angled head, power out (HIROSE), API (FirePackage, Direct FirePackage, Fire4Linux)

Table 21: Specification PIKE F-421B / F-421B fiber

Note

The design and specifications for the products described above may change without notice.

PIKE F-421C / F-421 C fiber

Feature	Specification
Image device	Type 1.2 (diag. 21.4 mm) type progressive scan KODAK IT CCD KAI4021
Lens mount	Adjustable C-Mount: 17.526 mm (in air); Ø 25.4 mm (32 tpi) mechanical flange back to filter distance: 12.5 mm (see Figure 35: Pike C-Mount dimensions (large filter for Pike F-100, F-145, F-210, F-421, F-505) on page 80)
Picture sizes (default modes)	320 x 240 pixels (Format_0 Mode_1) 640 x 480 pixels (Format_0 Mode_2 to Mode_5) 800 x 600 pixels (Format_1 Mode_0 to Mode_2) 1024 x 768 pixels (Format_1 Mode_3 to Mode_5) 1280 x 960 pixels (Format_2 Mode_0 to Mode_2) 1600 x 1200 pixels (Format_2 Mode_3 to Mode_5) 2048 x 2048 pixels (Format_7 Mode_0) 1024 x 2048 pixels (Format_7 Mode_4, 2 out of 4 H-sub-sampling) 2048 x 1024 pixels (Format_7 Mode_5, 2 out of 4 V-sub-sampling) 1024 x 1024 pixels (Format_7 Mode_6, 2 out of 4 full sub-sampling)
Cell size	7.4 µm x 7.4 µm
ADC	14 bit
Color modes	Raw8, Raw12, Raw16, Mono8, YUV4:2:2, YUV4:1:1, RGB8
Frame rates	1.875 fps; 3.75 fps; 7.5 fps; 15 fps; 30 fps up to 16 fps (Mono8, Raw8, no sub-sampling) up to 10 fps (Raw12, no sub-sampling) up to 10 fps (YUV 4:1:1, no sub-sampling) up to 8 fps (YUV 4:2:2, Raw16, no sub-sampling) up to 5 fps (RGB8, no sub-sampling)
Gain control	Manual: 0-20 dB (0.0353 dB/step); auto gain (select. AOI)
Shutter speed	**70** … 67.108.864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Programmable, trigger level control, single trigger, bulk trigger, programmable trigger delay
Internal FIFO memory	Up to 6 frames
# look-up tables	4 user programmable (14 bit → 14 bit); gamma (0.45 and 0.7)

Table 22: Specification PIKE F-421C / F-421C fiber

Feature	Specification
Smart functions	AGC (auto gain control), AEC (auto exposure control), AWB (auto white balance), color correction, hue, saturation, real-time shading correction, LUT, 64 MByte image memory, mirror, sub-sampling, High SNR, storable user sets Two configurable inputs, four configurable outputs RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s, 800 Mbit/s
Digital interface	IEEE 1394b (IIDC V1.31), 2 x copper connectors (bilingual) (daisy chain) **fiber**: IEEE 1394b, 2 connectors: 1 x copper (bilingual), 1 x GOF connector (2 x optical fiber on LCLC), (daisy chain)
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 12-pin HIROSE
Power consumption	Typical 5.5 watt (@ 12 V DC); **fiber:** typical 6.25 watt (@ 12 V DC)
Dimensions	96.8 mm x 44 mm x 44 mm (L x W x H); incl. connectors, w/o tripod and lens
Mass	250 g (without lens)
Operating temperature	+ 5 °C ... + 50 °C housing temperature (without condensation)
Storage temperature	- 10 °C ... + 60 °C ambient temperature (without condensation)
Regulations	EN 55022, EN 61000, EN 55024, FCC Class B, DIN ISO 9022, RoHS (2002/95/EC)
Options	Protection glass M39-Mount suitable for e.g. Voigtländer optics Adjustable M39-Mount: 28.80 mm (in air); M39 x 26 tpi mechanical flange back to filter distance: 24.2 mm (see Figure 37: Pike M39-Mount dimensions (only Pike F-210 and Pike F-421) on page 82) host adapter card, angled head, power out (HIROSE), API (FirePackage, Direct FirePackage, Fire4Linux)

Table 22: Specification PIKE F-421C / F-421C fiber

Note

The design and specifications for the products described above may change without notice.

PIKE F-505B / F-505B fiber

Feature	Specification
Image device	Type 2/3 (diag. 11.016 mm) progressive scan SONY ICX625
Lens mount	Adjustable C-Mount: 17.526 mm (in air); Ø 25.4 mm (32 tpi) mechanical flange back to filter distance: 12.5 mm (see Figure 35: Pike C-Mount dimensions (large filter for Pike F-100, F-145, F-210, F-421, F-505) on page 80)
Picture sizes (default modes)	640 x 480 pixels (Format_0 Mode_5 and Mode_6) 800 x 600 pixels (Format_1 Mode_2 and Mode_6) 1024 x 768 pixels (Format_1 Mode_5 and Mode_7) 1280 x 960 pixels (Format_2 Mode_2 and Mode_6) 1600 x 1200 pixels (Format_2 Mode_5 and Mode_7) 2452 x 2054 pixels (Format_7 Mode_0) 1224 x 2054 pixels (Format_7 Mode_1, 2 x H-binning) 2452 x 1026 pixels (Format_7 Mode_2, 2 x V-binning) 1224 x 1026 pixels (Format_7 Mode_3, 2 x full binning) 1224 x 2054 pixels (Format_7 Mode_4, 2 out of 4 H-sub-sampling) 2452 x 1026 pixels (Format_7 Mode_5, 2 out of 4 V-sub-sampling) 1224 x 1026 pixels (Format_7 Mode_6, 2 out of 4 full sub-sampling)
Cell size	3.45 µm x 3.45 µm
ADC	14 bit
Frame rates	1.875 fps; 3.75 fps; 7.5 fps; 15 fps up to 15* fps in Format_7 (Mono8 no sub-sampling) up to 9 fps in Format_7 (Mono12 no sub-sampling) up to 7 fps in Format_7 (Mono16 no sub-sampling) * at 11000 bytes per packet
Gain control	Manual: 0-24 dB (0.0359 dB/step); auto gain (select. AOI)
Shutter speed	**27** µs … 67.108.864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Programmable, trigger level control, single trigger, bulk trigger, programmable trigger delay
Internal FIFO memory	Up to 5 frames
# look-up tables	4 user programmable (14 bit → 14 bit); gamma (0.45 and 0.7)
Smart functions	AGC (auto gain control), AEC (auto exposure control), real-time shading correction, LUT, 64 MByte image memory, mirror, binning, sub-sampling, High SNR, storable user sets Two configurable inputs, four configurable outputs RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s, 800 Mbit/s

Table 23: Specification PIKE F-505B / F-505B fiber

Feature	Specification
Digital interface	IEEE 1394b (IIDC V1.31), 2 x copper connectors (bilingual) (daisy chain) **fiber**: IEEE 1394b, 2 connectors: 1 x copper (bilingual), 1 x GOF connector (2 x optical fiber on LCLC), (daisy chain)
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 12-pin HIROSE
Power consumption	Typical 5.75 watt (@ 12 V DC); **fiber:** typical 6.50 watt (@ 12 V DC)
Dimensions	96.8 mm x 44 mm x 44 mm (L x W x H); incl. connectors, w/o tripod and lens
Mass	250 g (without lens)
Operating temperature	+ 5 °C ... + 50 °C housing temperature (without condensation)
Storage temperature	- 10 °C ... + 60 °C ambient temperature (without condensation)
Regulations	EN 55022, EN 61000, EN 55024, FCC Class B, DIN ISO 9022, RoHS (2002/95/EC)
Options	IR cut filter, IR pass filter, host adapter card, angled head, power out (HIROSE), API (FirePackage, Direct FirePackage, Fire4Linux)

Table 23: Specification PIKE F-505B / F-505B fiber

Note

The design and specifications for the products described above may change without notice.

PIKE F-505C / F-505C fiber

Feature	Specification
Image device	Type 2/3 (diag. 11.016 mm) type progressive scan SONY ICX625
Lens mount	Adjustable C-Mount: 17.526 mm (in air); Ø 25.4 mm (32 tpi) mechanical flange back to filter distance: 12.5 mm (see Figure 35: Pike C-Mount dimensions (large filter for Pike F-100, F-145, F-210, F-421, F-505) on page 80)
Picture sizes (default modes)	320 x 240 pixels (Format_0 Mode_1) 640 x 480 pixels (Format_0 Mode_2 to Mode_5) 800 x 600 pixels (Format_1 Mode_0 to Mode_2) 1024 x 768 pixels (Format_1 Mode_3 to Mode_5) 1280 x 960 pixels (Format_2 Mode_0 to Mode_2) 1600 x 1200 pixels (Format_2 Mode_3 to Mode_5) 2452 x 2054 pixels (Format_7 Mode_0) 1224 x 2054 pixels (Format_7 Mode_4, 2 out of 4 H-sub-sampling) 2452 x 1026 pixels (Format_7 Mode_5, 2 out of 4 V-sub-sampling) 1224 x 1026 pixels (Format_7 Mode_6, 2 out of 4 full sub-sampling)
Cell size	3.45 µm x 3.45 µm
ADC	14 bit
Color modes	Raw8, Raw12, Raw16, Mono8, YUV4:2:2, YUV4:1:1, RGB8
Frame rates	1.875 fps; 3.75 fps; 7.5 fps; 15 fps up to 15* fps in Format_7 (Mono8, Raw8, no sub-sampling) up to 9 fps in Format_7 (Raw12, no sub-sampling) up to 9 fps (YUV 4:1:1, no sub-sampling) up to 7 fps (YUV 4:2:2, Raw16, no sub-sampling) up to 4 fps (RGB8, no sub-sampling) * at 11000 bytes per packet
Gain control	Manual: 0-24 dB (0.0359 dB/step); auto gain (select. AOI)
Shutter speed	**27** µs … 67.108.864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Programmable, trigger level control, single trigger, bulk trigger, programmable trigger delay
Internal FIFO memory	Up to 5 frames
# look-up tables	4 user programmable (14 bit → 14 bit); gamma (0.45 and 0.7)

Table 24: Specification PIKE F-505C / F-505C fiber

Feature	Specification
Smart functions	AGC (auto gain control), AEC (auto exposure control), AWB (auto white balance), color correction, hue, saturation, real-time shading correction, LUT, 64 MByte image memory, mirror, sub-sampling, High SNR, storable user sets Two configurable inputs, four configurable outputs RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s, 800 Mbit/s
Digital interface	IEEE 1394b (IIDC V1.31), 2 x copper connectors (bilingual) (daisy chain) **fiber**: IEEE 1394b, 2 connectors: 1 x copper (bilingual), 1 x GOF connector (2 x optical fiber on LCLC), (daisy chain)
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 12-pin HIROSE
Power consumption	Typical 5.75 watt (@ 12 V DC); **fiber:** typical 6.50 watt (@ 12 V DC)
Dimensions	96.8 mm x 44 mm x 44 mm (L x W x H); incl. connectors, w/o tripod and lens
Mass	250 g (without lens)
Operating temperature	+ 5 °C ... + 50 °C housing temperature (without condensation)
Storage temperature	- 10 °C ... + 60 °C ambient temperature (without condensation)
Regulations	EN 55022, EN 61000, EN 55024, FCC Class B, DIN ISO 9022, RoHS (2002/95/EC)
Options	Protection glass, host adapter card, angled head, power out (HIROSE), API (FirePackage, Direct FirePackage, Fire4Linux)

Table 24: Specification PIKE F-505C / F-505C fiber

Note

The design and specifications for the products described above may change without notice.

Spectral sensitivity

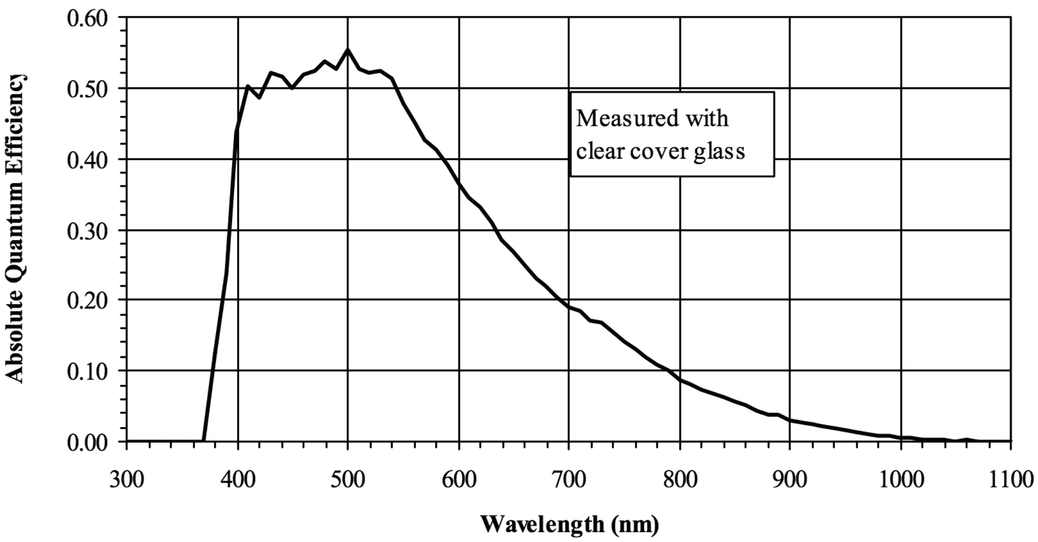


Figure 10: Spectral sensitivity of Pike F-032B

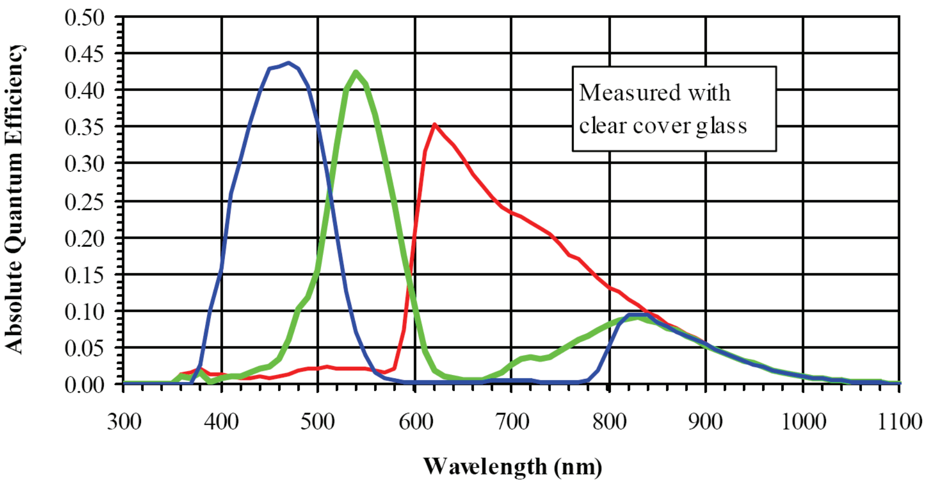


Figure 11: Spectral sensitivity of Pike F-032C

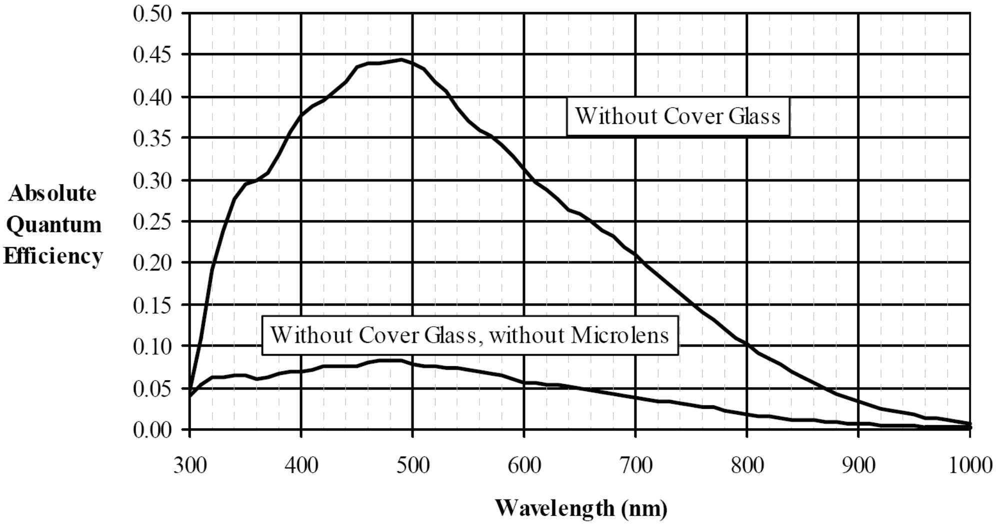


Figure 12: Spectral sensitivity of Pike F-100B

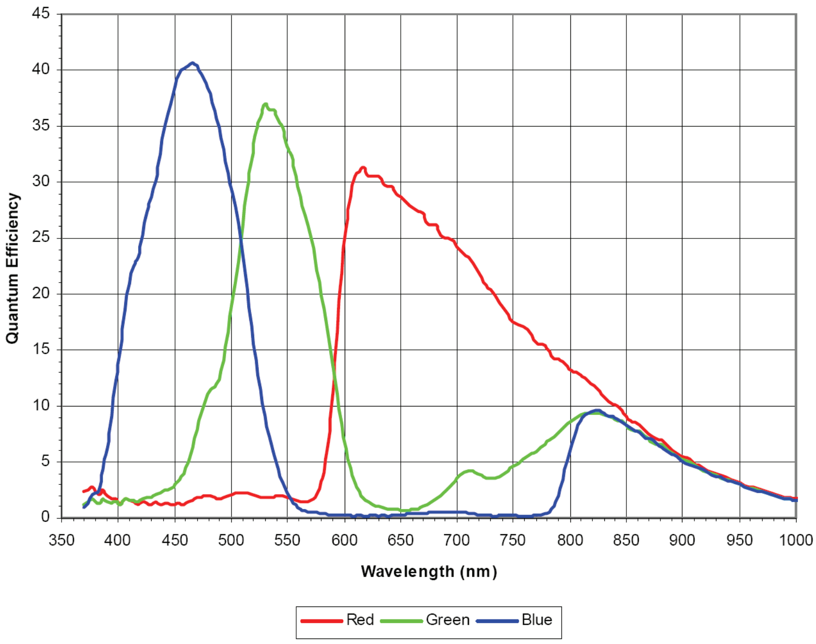


Figure 13: Spectral sensitivity of Pike F-100C

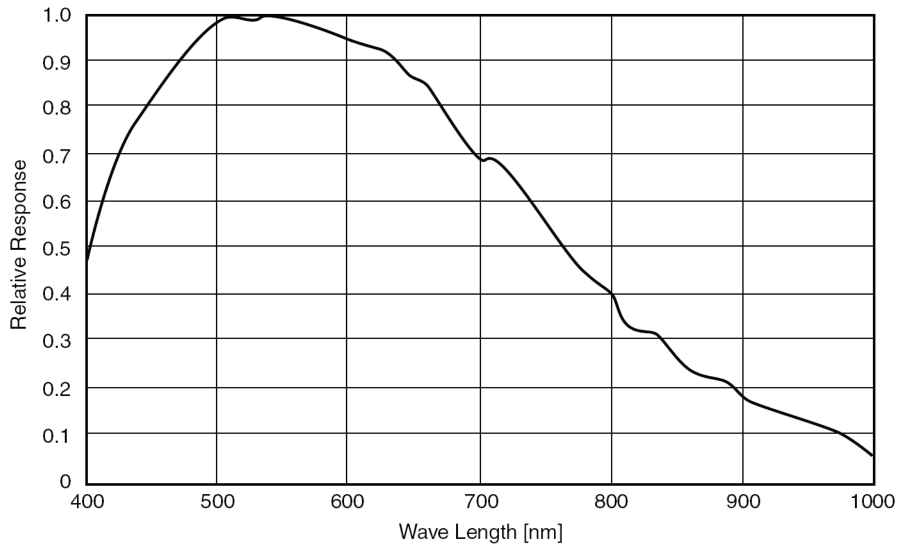


Figure 14: Spectral sensitivity of Pike F-145B

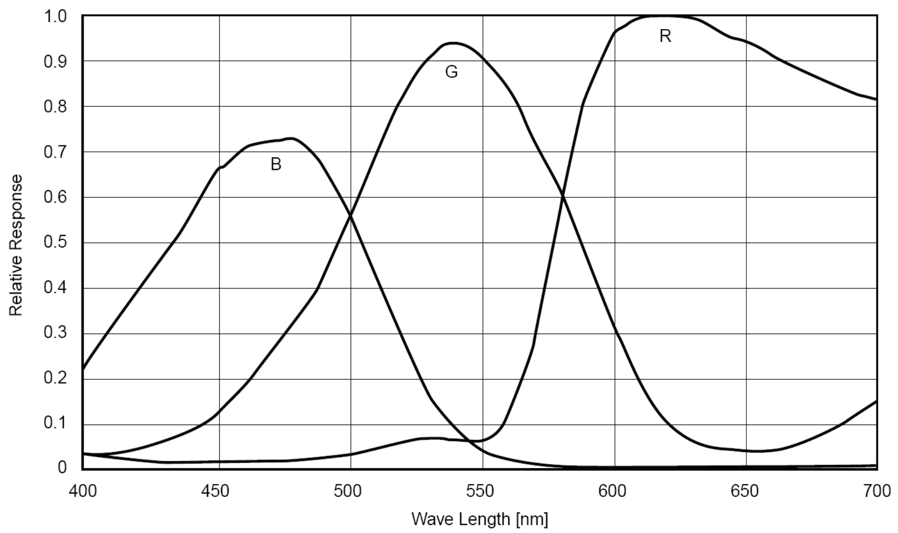


Figure 15: Spectral sensitivity of Pike F-145C

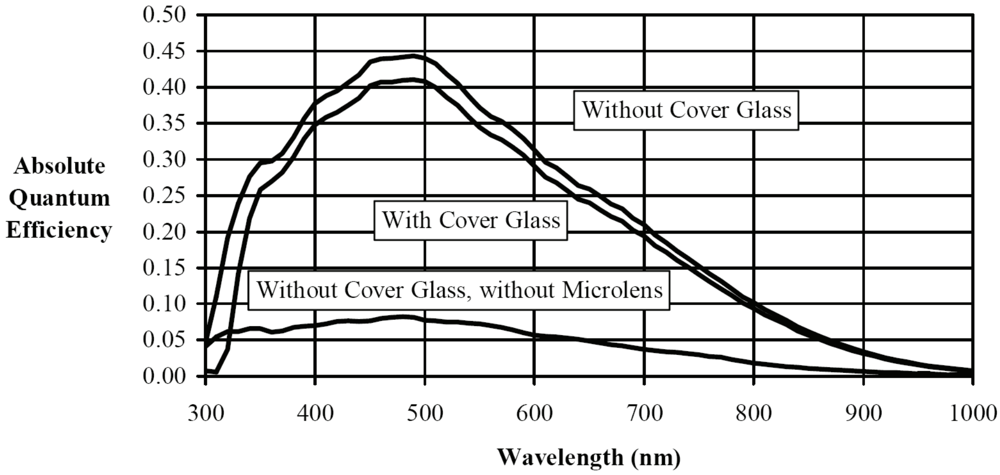


Figure 16: Spectral sensitivity of Pike F-210B

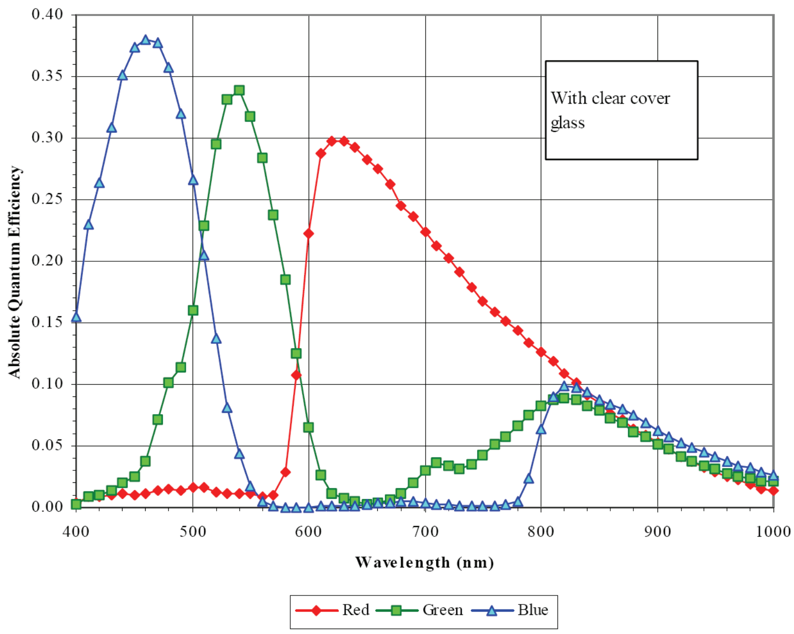


Figure 17: Spectral sensitivity of Pike F-210C

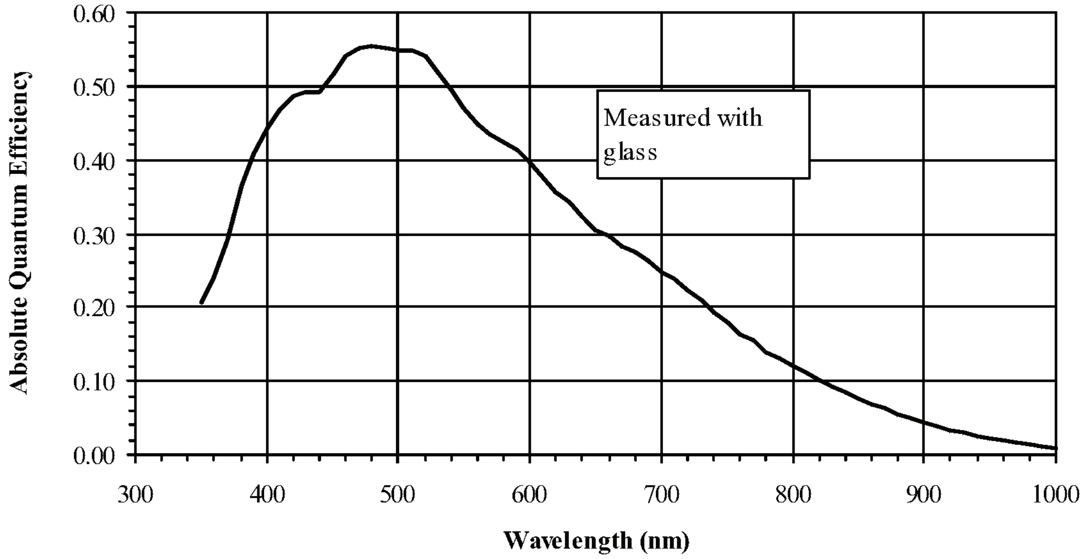


Figure 18: Spectral sensitivity of Pike F-421B

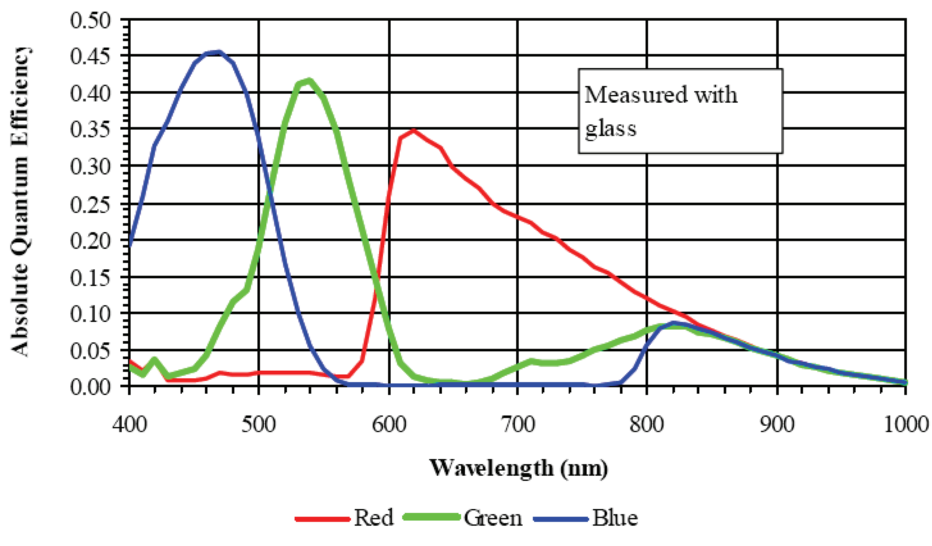


Figure 19: Spectral sensitivity of Pike F-421C

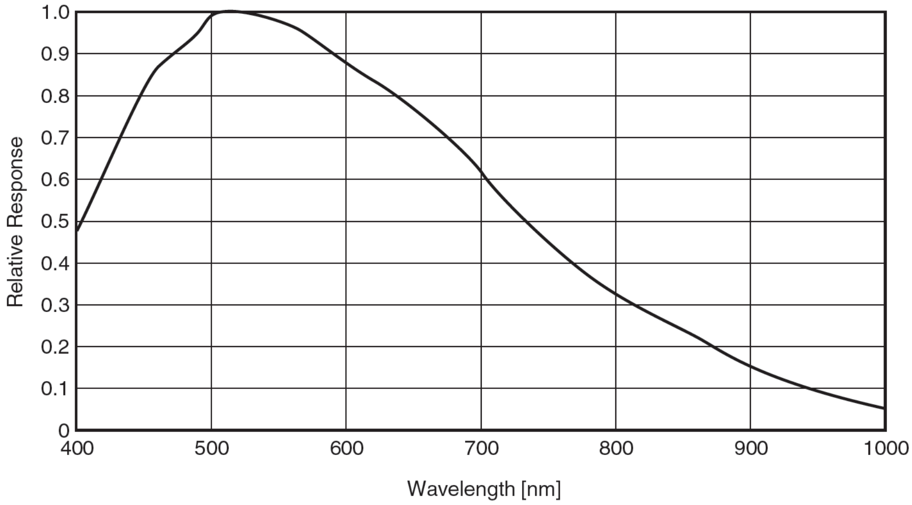


Figure 20: Spectral sensitivity of Pike F-505B

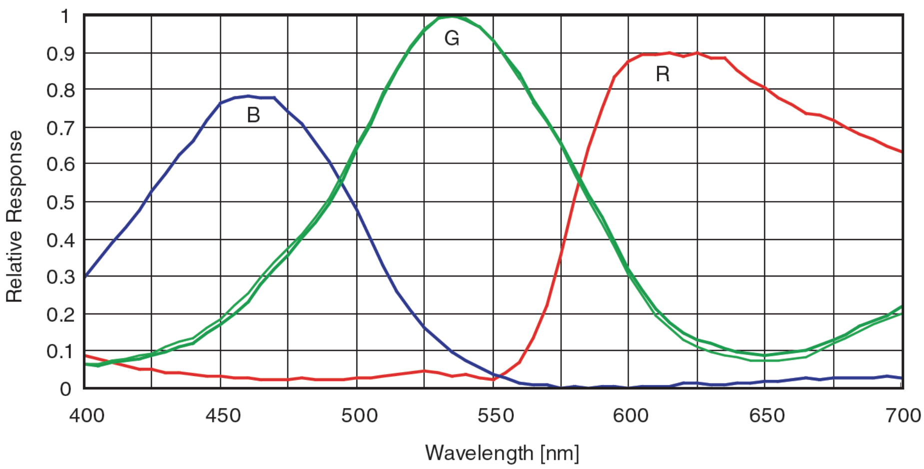


Figure 21: Spectral sensitivity of Pike F-505C

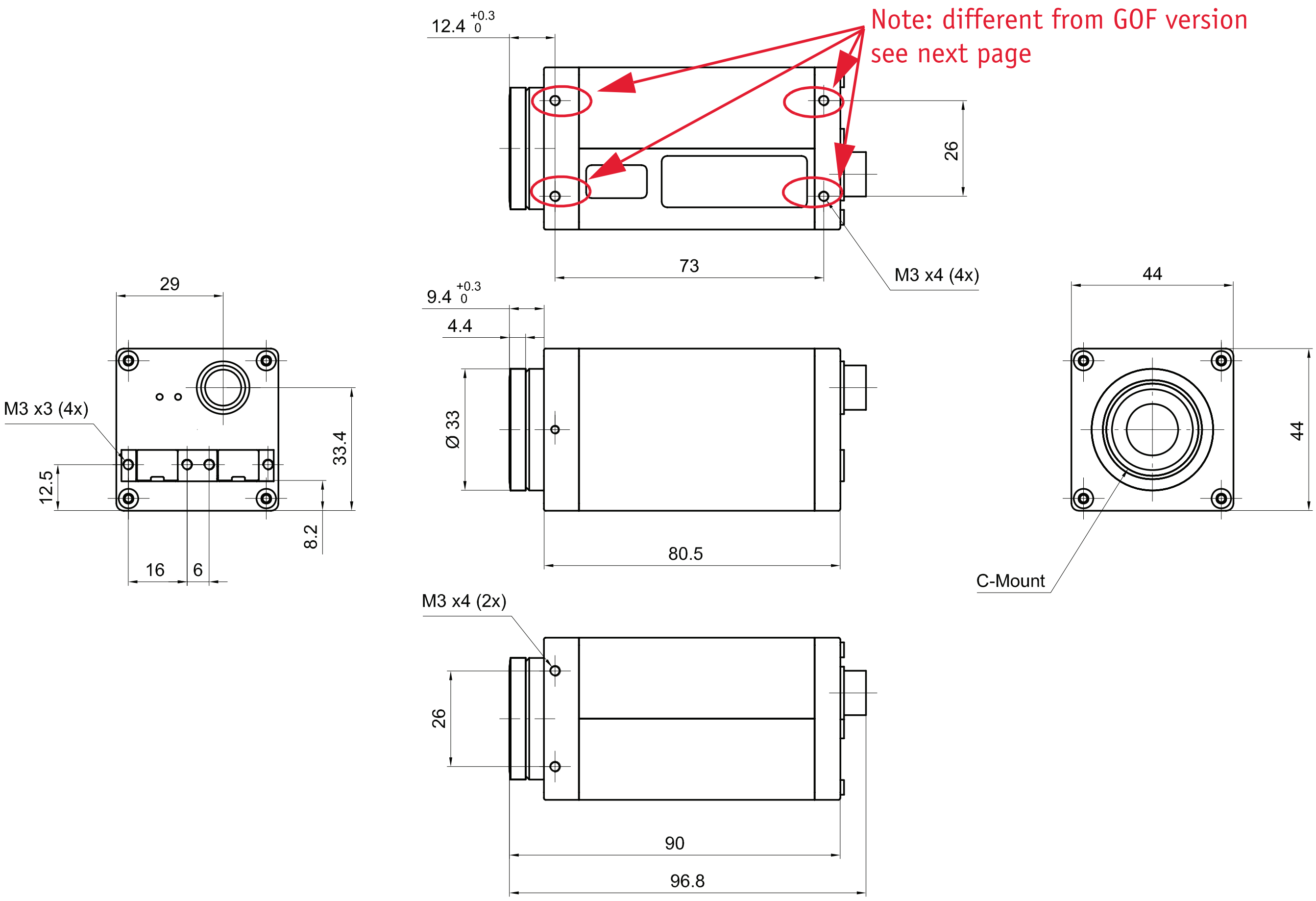
Camera dimensions

Note

For information on **sensor position accuracy:**

(sensor shift x/y, optical back focal length z and sensor rotation α) see Chapter Sensor position accuracy of AVT cameras on page 322.

PIKE standard housing (2 x 1394b copper)

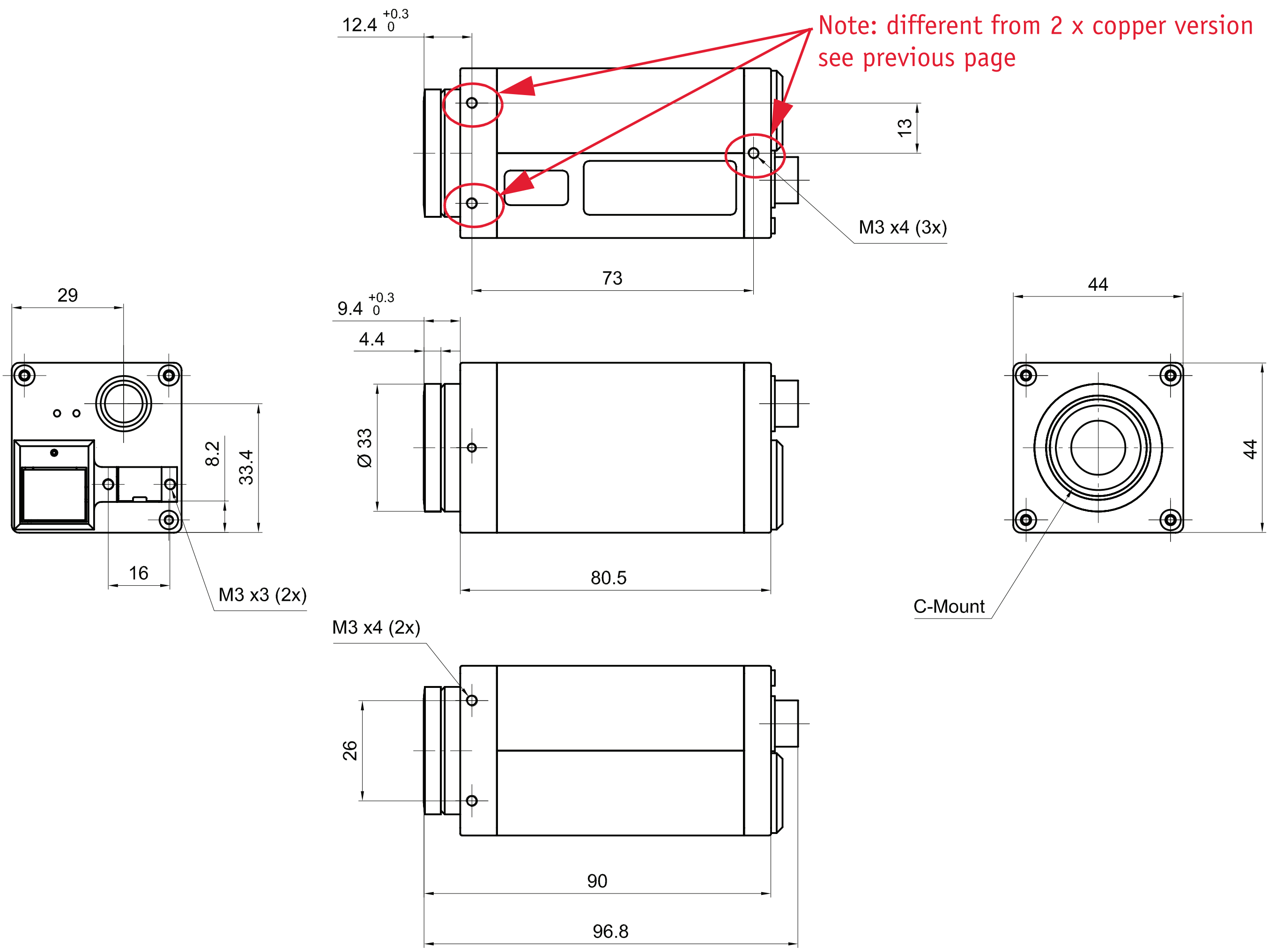


Body size: 96.8 mm x 44 mm x 44 mm (L x W x H)

Mass: 250 g (without lens)

Figure 22: Camera dimensions (2 x 1394b copper)

PIKE (1394b: 1 x GOF, 1 x copper)



Body size: 96.8 mm x 44 mm x 44 mm (L x W x H)

Mass: 250 g (without lens)

Figure 23: Camera dimensions (1394b: 1 x GOF, 1 x copper)

Tripod adapter

This tripod adapter is only designed for standard housings, but not for the angled head versions.

Note

If you need a tripod adapter for angled head versions, please contact AVT support.

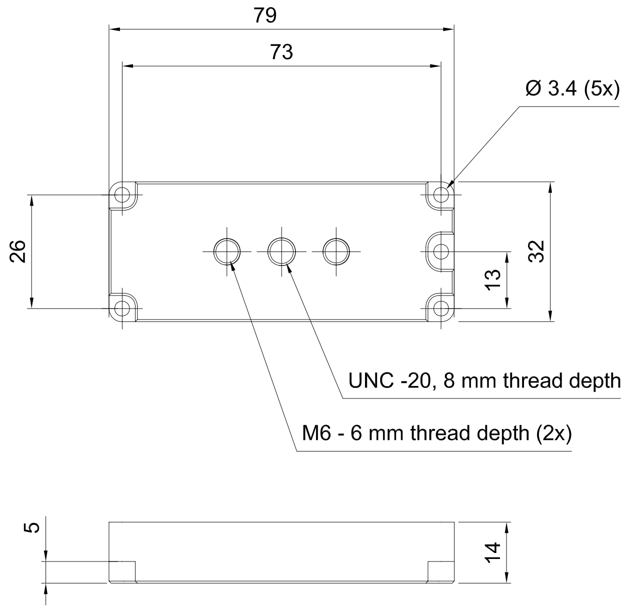


Figure 24: Tripod dimensions

Pike W90 (2 x 1394b copper)

This version has the sensor tilted by 90 degrees clockwise, so that it views upwards.

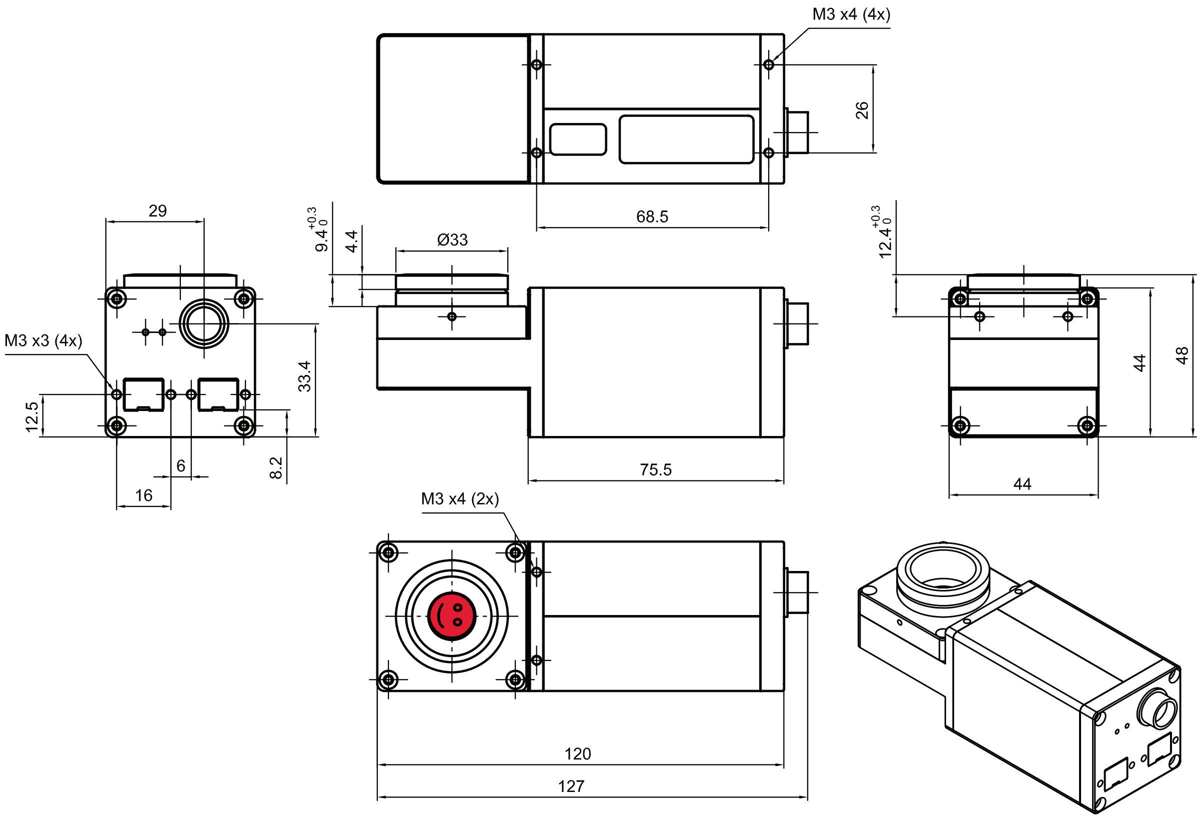


Figure 25: Pike W90 (2 x 1394b copper)

Pike W90 (1394b: 1 x GOF, 1 x copper)

This version has the sensor tilted by 90 degrees clockwise, so that it views upwards.

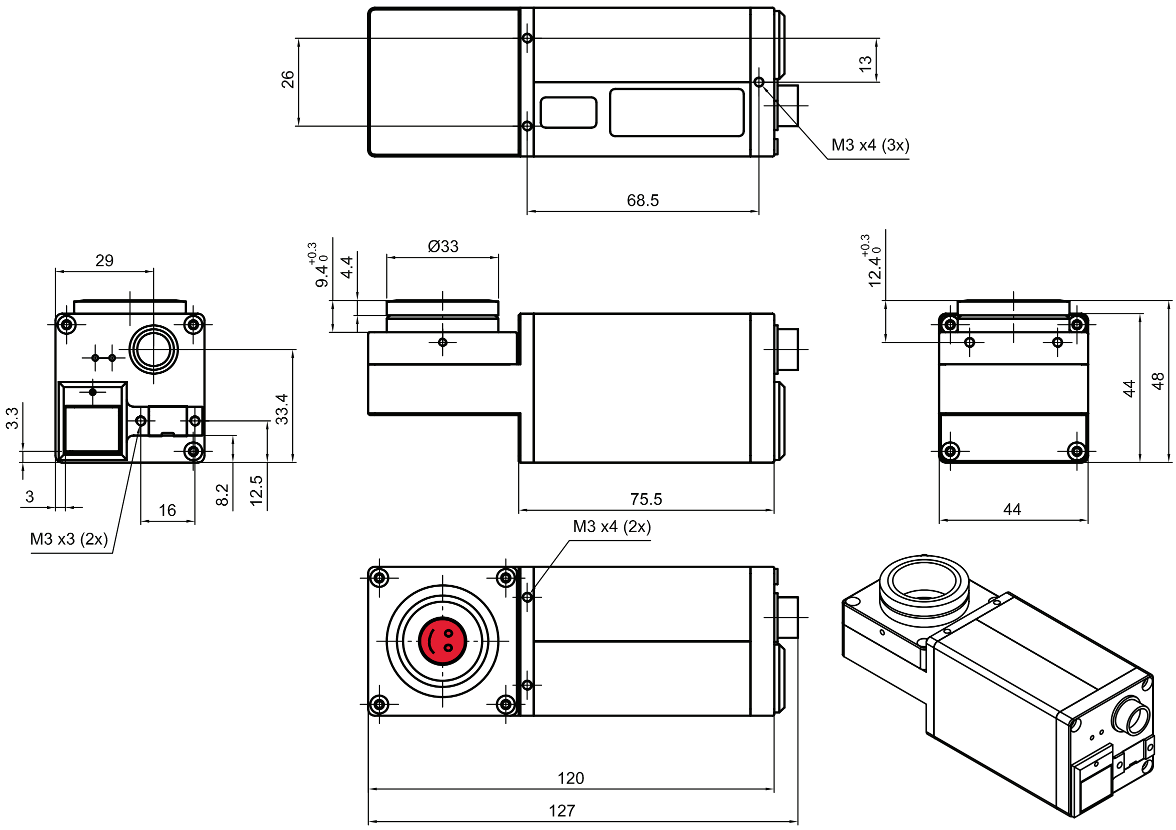


Figure 26: Pike W90 (1394b: 1 x GOF, 1 x copper)

Pike W90 S90 (2 x 1394b copper)

This version has the sensor tilted by 90 degrees clockwise, so that it views upwards.

The sensor is also rotated by 90 degrees clockwise.

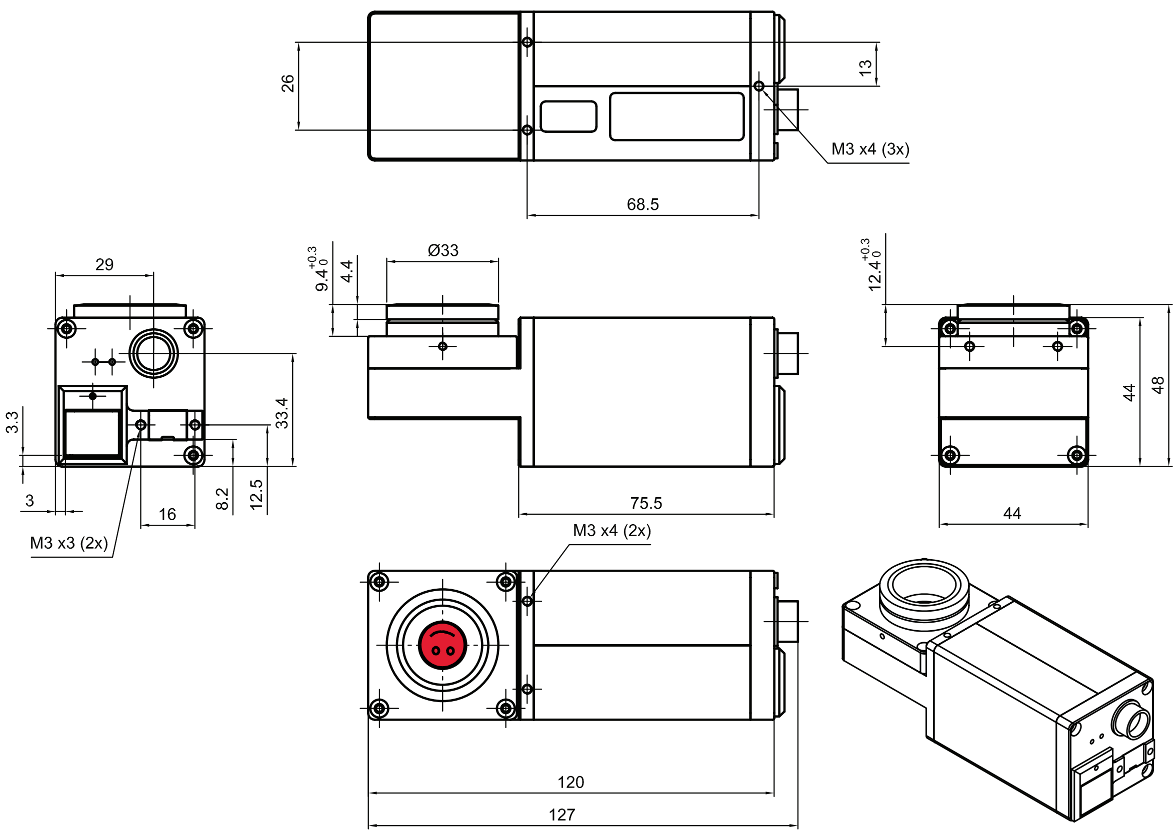


Figure 27: Pike W90 S90 (1394b: 1 x GOF, 1 x copper)

Pike W90 S90 (1394b: 1 x GOF, 1 x copper)

This version has the sensor tilted by 90 degrees clockwise, so that it views upwards.

The sensor is also rotated by 90 degrees clockwise.

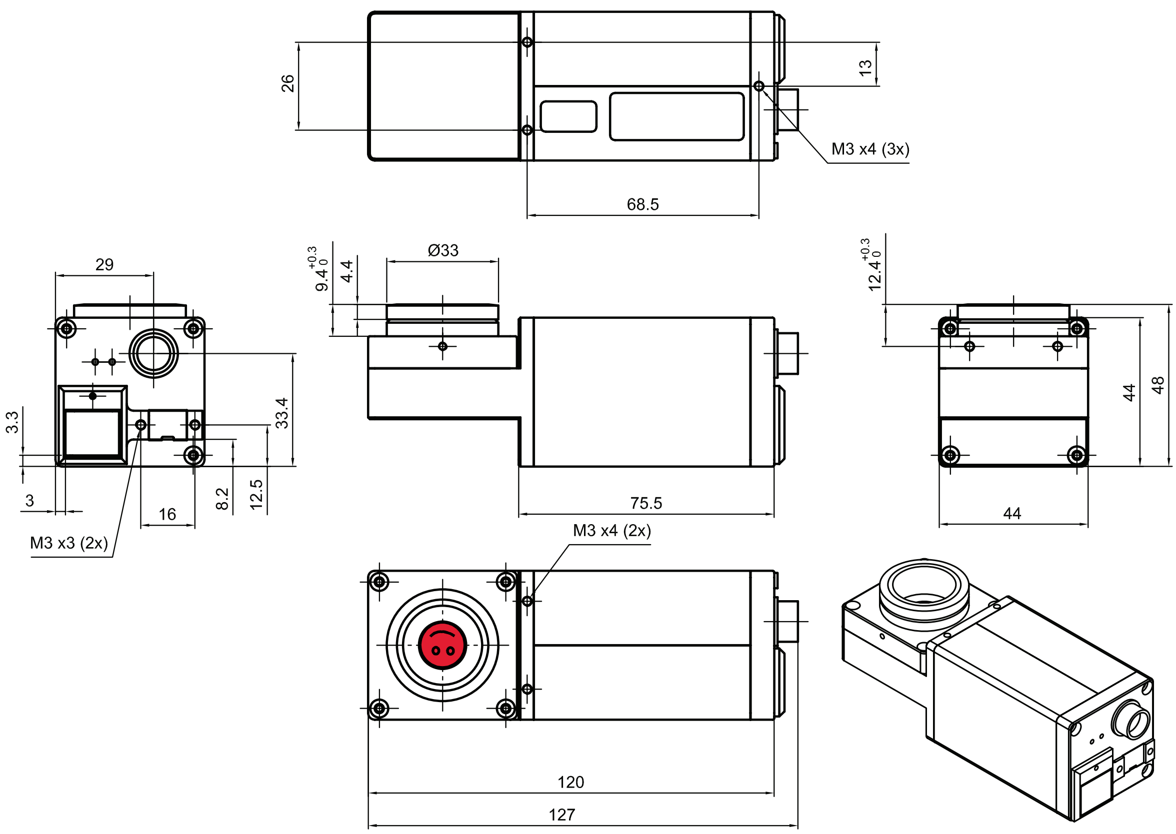


Figure 28: Pike W90 S90 (1394b: 1 x GOF, 1 x copper)

Pike W270 (2 x 1394b copper)

This version has the sensor tilted by 270 degrees clockwise, so that it views downwards.

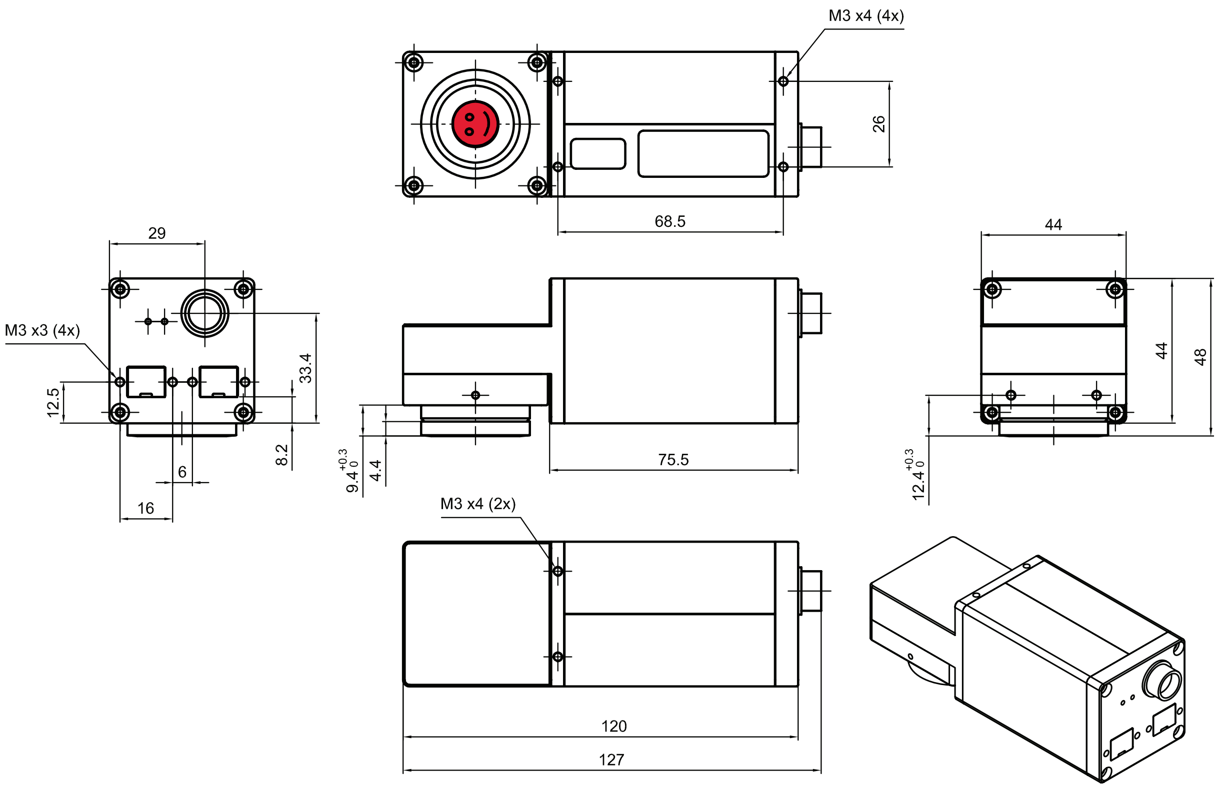


Figure 29: Pike W270 (2 x 1394b copper)

Pike W270 (1394b: 1 x GOF, 1 x copper)

This version has the sensor tilted by 270 degrees clockwise, so that it views downwards.

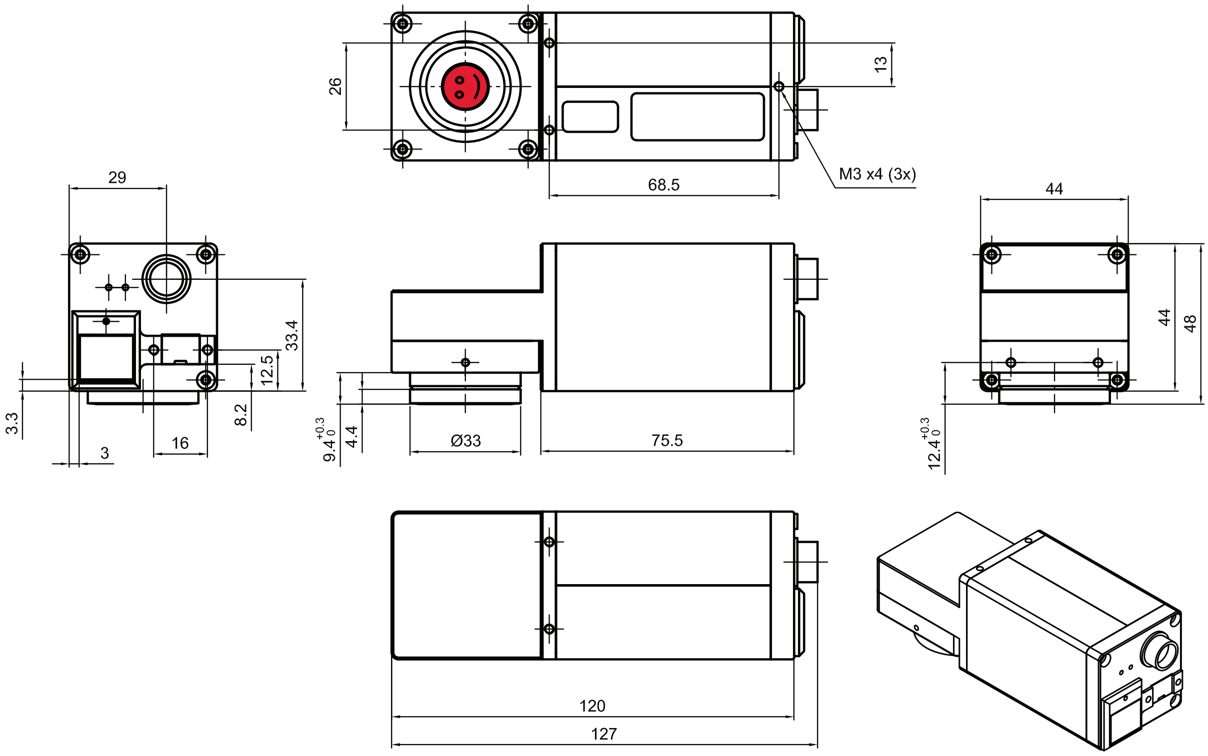


Figure 30: Pike W270 (1394b: 1 x GOF, 1 x copper)

Pike W270 S90 (2 x 1394b copper)

This version has the sensor tilted by 270 degrees clockwise, so that it views downwards.

The sensor is also rotated by 90 degrees clockwise.

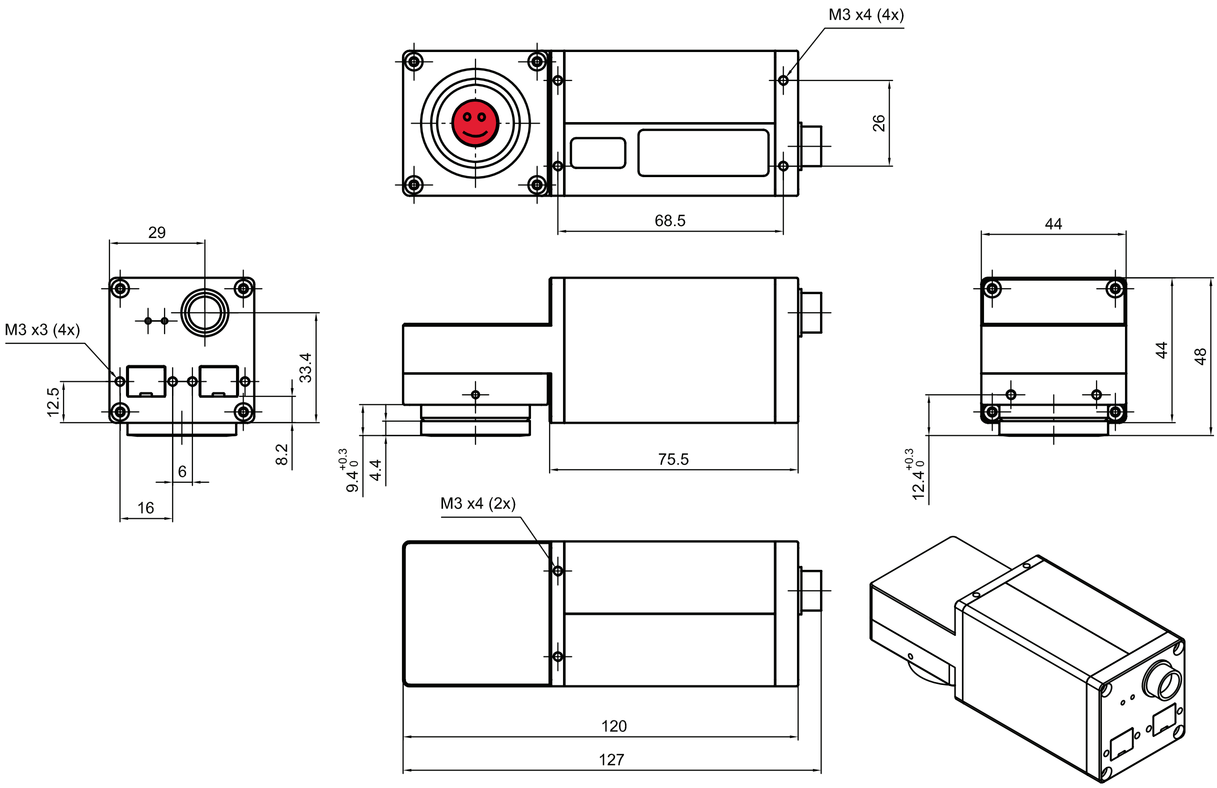


Figure 31: Pike W270 S90 (2 x 1394b copper)

Pike W270 S90 (1394b: 1 x GOF, 1 x copper)

This version has the sensor tilted by 270 degrees clockwise, so that it views downwards.

The sensor is also rotated by 90 degrees clockwise.

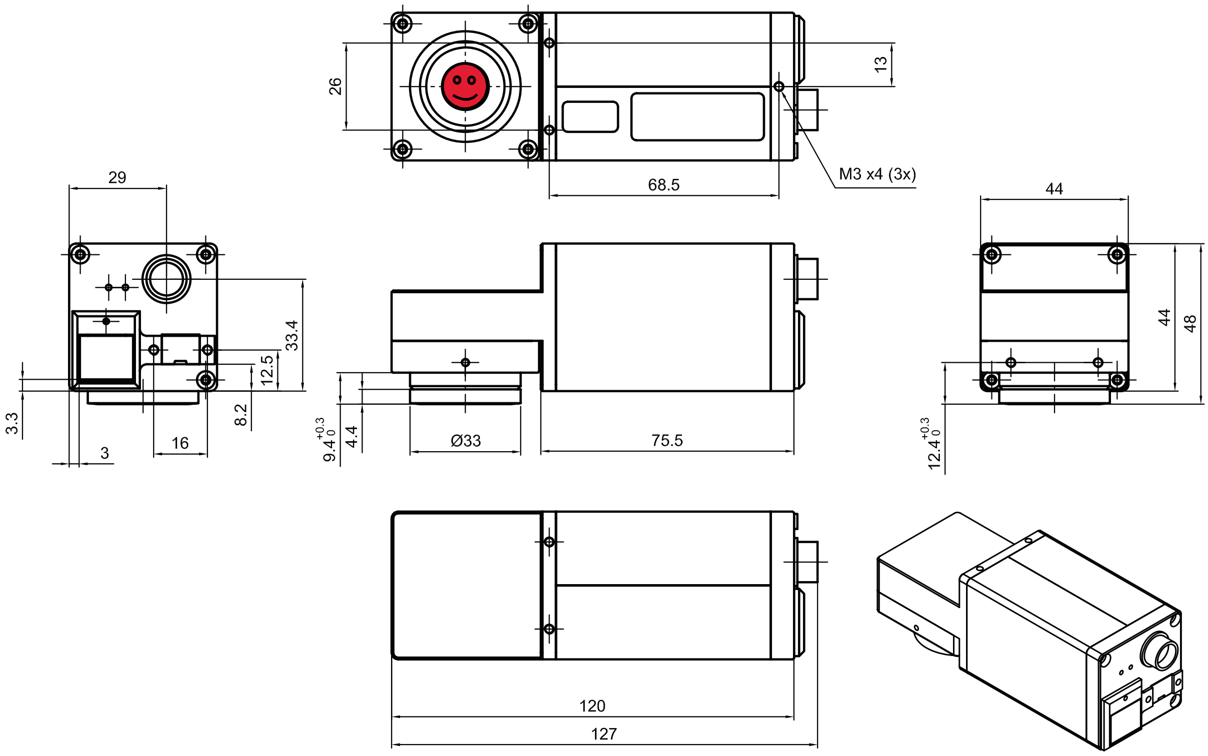


Figure 32: Pike W270 S90 (1394b: 1 x GOF, 1 x copper)

Cross section: CS-Mount (only PIKE F-032B/C)

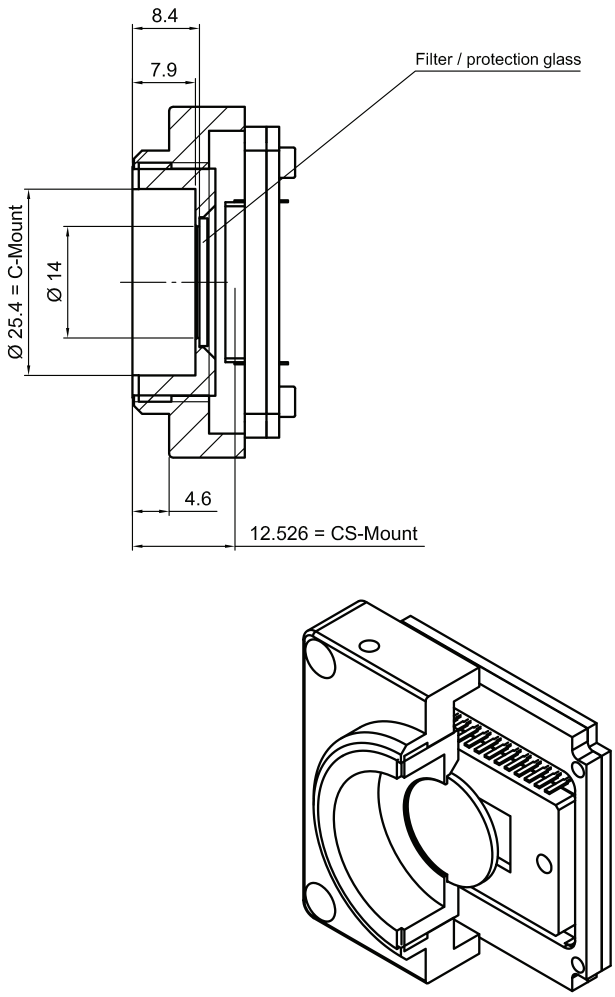


Figure 33: Pike CS-Mount dimensions (only PIKE F-032B/C)

Cross section: C-Mount (VGA size filter)

PIKE F-032 cameras are equipped with VGA size filter.

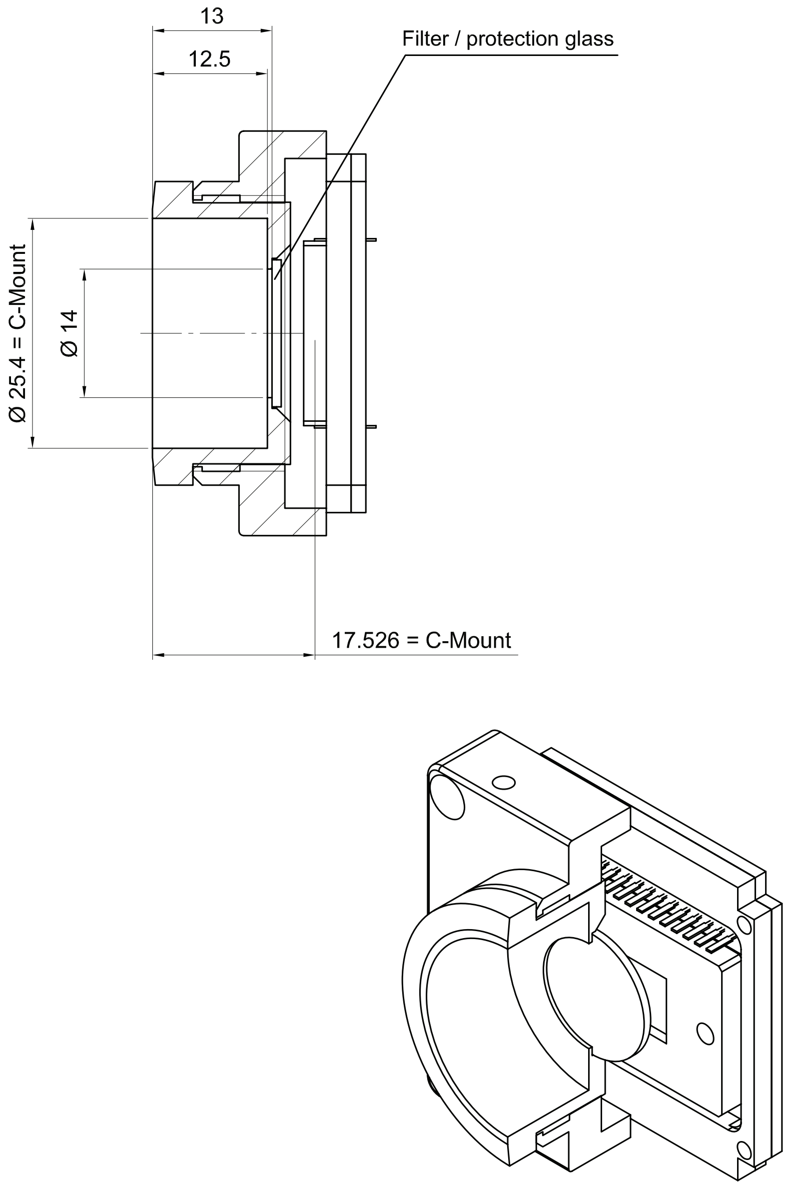


Figure 34: Pike C-Mount dimensions (VGA size filter for Pike F-032)

Cross section: C-Mount (large filter)

PIKE F-100, PIKE F-145, PIKE F-210, PIKE F-421, PIKE F-505 are equipped with a large filter.

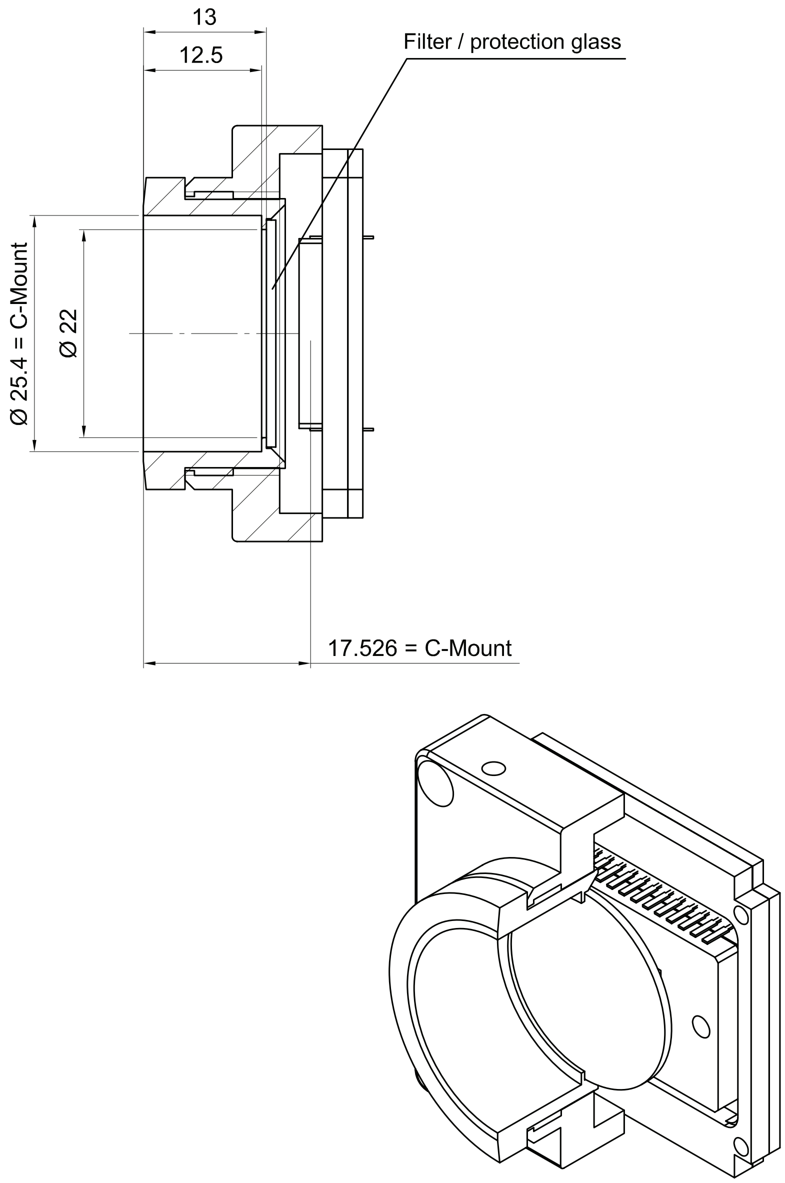


Figure 35: Pike C-Mount dimensions (large filter for Pike F-100, F-145, F-210, F-421, F-505)

Adjustment of C-Mount

PIKE cameras allow the precise adjustment of the back focus of the C-Mount by means of a **back focus ring** which is threaded into the C-Mount and held by **two** screws on either side of the camera. The mechanical adjustment of the imaging device is important in order to achieve a perfect alignment with the focal point of the lens.

Individual adjustment may be required:

- if you cannot focus correctly at near or far distances or
- if the back focal plane of your lens does not conform to the C-Mount back-focus specification or
- if you have e.g. removed the IR cut filter.

Figure 36: Back focus adjustment

Do the following:

1. Loosen screws (location as shown above by arrow) with an Allen key (1.3 x 50; Order#: K 9020411).
2. With the lens set to infinity or a known focus distance, set the camera to view an object located at 'infinity' or the known distance.
3. Rotate the C-Mount ring and lens forward or backwards on its thread until the object is in sharp focus. Be careful that the lens remains seated in the C-Mount.
4. Once focus is achieved, tighten the two locking screws without applying excessive torque.

F-Mount, K-Mount, M39-Mount

Note

For other mounts (e.g. **F-Mount**, **K-Mount**) please contact your distributor.

Note

Pike F-210 and Pike F-421 can be equipped at factory site with **M39-Mount** instead of C-Mount.

M39-Mount is ideally suited for Voigtländer (aka Voigtlander) short focal length optics. See drawing below for further details.

Please ask AVT or your local dealer if you require further information.

Cross section: M39-Mount

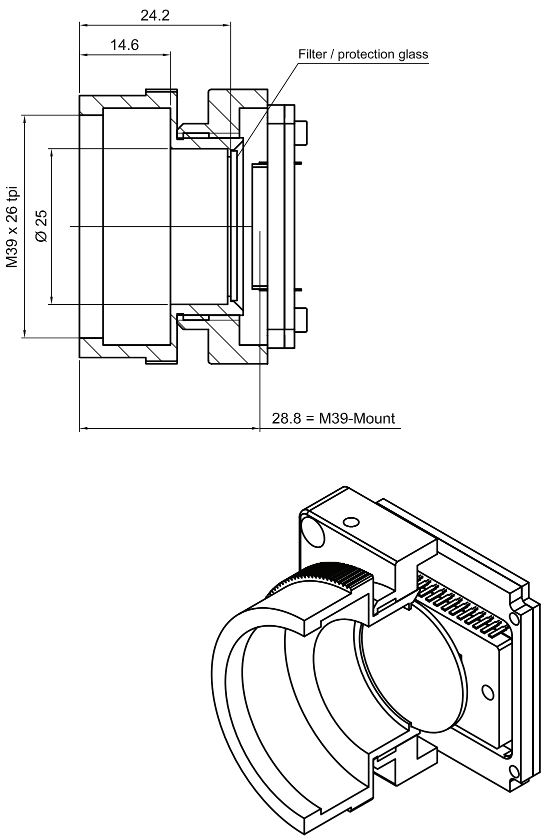


Figure 37: Pike M39-Mount dimensions (only Pike F-210 and Pike F-421)

Camera interfaces

In addition to the two status LEDs (see Chapter Status LEDs on page 90), there are three jacks located at the rear of the camera.

- The 12-pin camera I/O connector provides different control inputs and output lines.
- Both IEEE 1394b connectors with screw lock mechanism provide access to the IEEE 1394 bus and thus makes it possible to control the camera and output frames. Connect the camera by using either of the connectors. The other connector can be used to daisy chain a second camera.

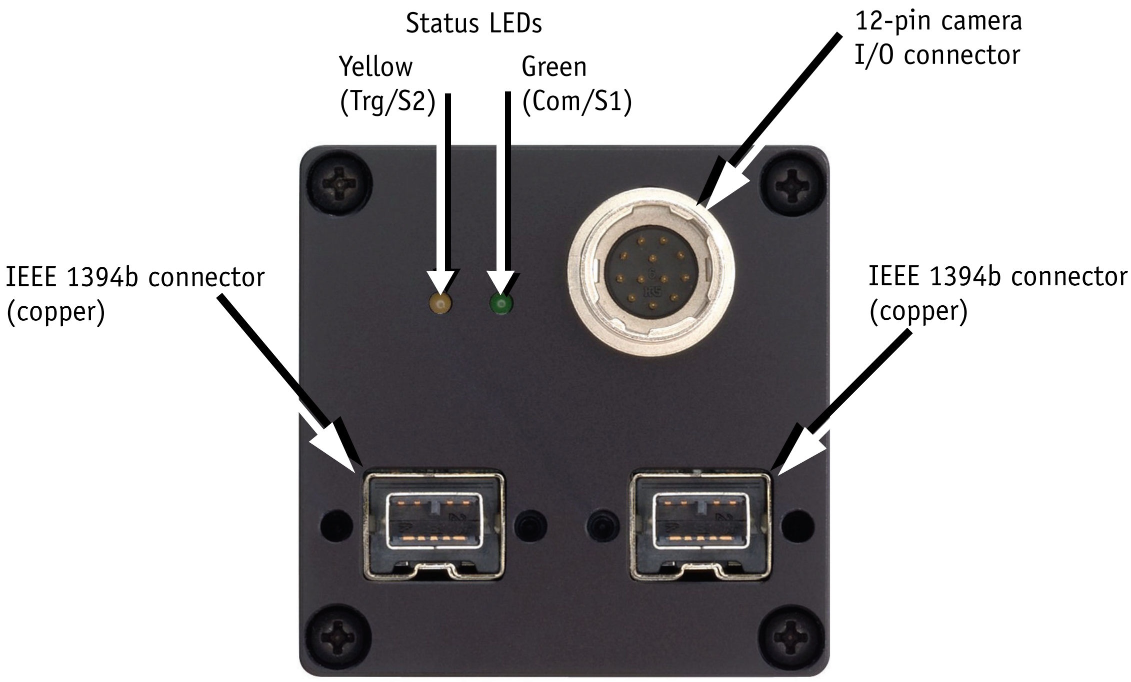


Figure 38: Rear view of camera (2 x 1394b copper)

PIKE fiber

All PIKE cameras are also available as fiber version with 1 x GOF connector and 1 x copper connector.

The GOF connector is of the following type: 2 x optical fiber on LCLC

The GOF transmission uses MMF (multi-mode fiber at 850 nm).

Connect the camera by using either of the connectors. The other connector can be used to daisy chain a second camera. In case of long distances between PC and camera, use the GOF connector for the long distance and the IEEE 1394b connector for optional daisy-chaining. Please ensure that you use a GOF hub on the PC side for reconversion from GOF to copper (order number E3000074 (with mounting plate) or E3000084 (with top-hat rail)). Alternatively use PCI or PCIExpress cards with built in GOF port. Ask your dealer for availability and details of these cards.

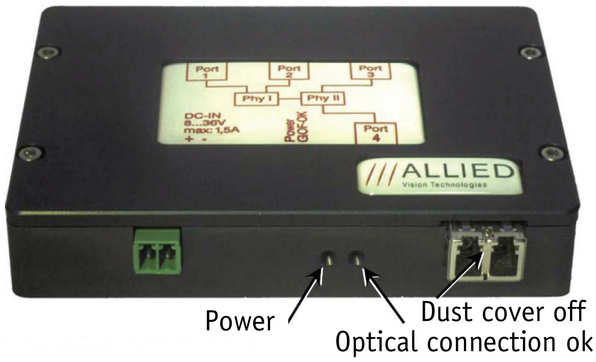


Figure 39: GOF hub

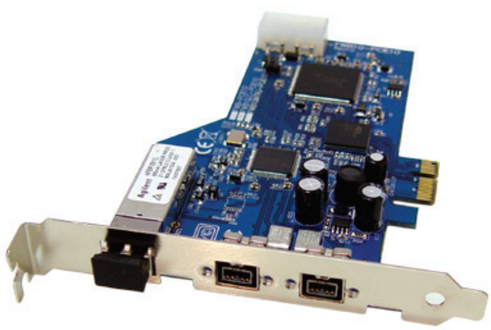


Figure 40: PCI Express card (1 x GOF, 2 x 1394 bilingual)

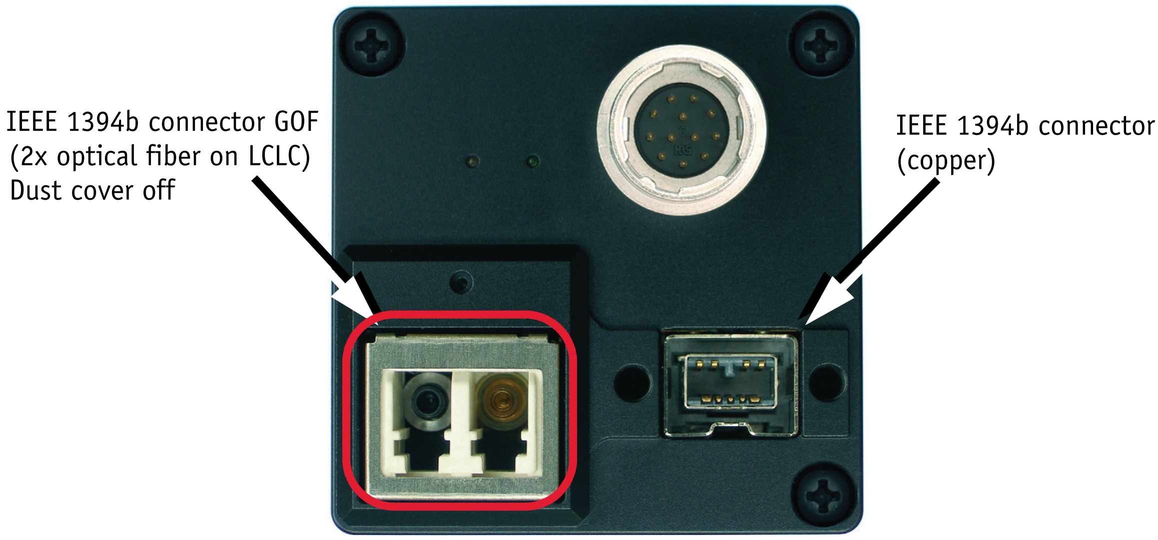


Figure 41: Rear view of camera (1394b: 1 x GOF, 1 x copper)

Warning

Special warning for all PIKE models with GOF connectors:

GOF connectors are very sensitive. Any dust or dirt may cause damage.

- Always keep the GOF connector and optical fiber plug clean.
- If GOF connection is not in use, keep GOF dust cover on the GOF connector.
- Reduce mating cycles to a minimum to prevent abrasion.
- Please note that optical fiber cables have a very limited deflection curve radius.

IEEE 1394b port pin assignment

The IEEE 1394b connector is designed for industrial use and has the following pin assignment as per specification:

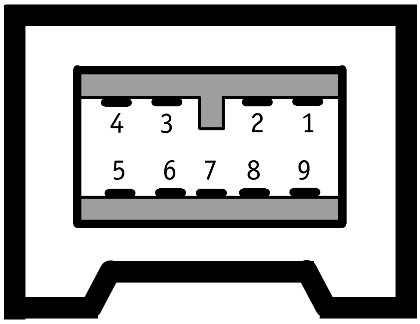


Figure 42: IEEE 1394b connector

Pin	Signal
1	TPB-
2	TPB+
3	TPA-
4	TPA+
5	TPA (Reference ground)
6	VG (GND)
7	N.C.
8	VP (Power, VCC)
9	TPB (Reference ground)

Table 25: IEEE 1394b pin assignment

Note

Cables with latching connectors on one or both sides can be used and are available with lengths of 5 m or 7.5 m. Ask your local dealer for more details.

Camera I/O connector pin assignment

The camera I/O connector is also designed for industrial use and, in addition to providing access to the inputs and outputs on the camera, it also provides a serial interface for e.g. the firmware update. The following diagram shows the pinning as viewed in pin direction.

The connector is available in straight and angled version under the following numbers:

Order text	Order number
PC-12P 12-Pin HR10A-10P-12S cable connector female	K7600040
PC-12PW 12-Pin HR10A-10LT-12S angled cable connector female	K7600044

Table 26: Order numbers: I/O connector

Note

AVT supplies suitable I/O cables of different lengths (up to 10 m) as shown below.

Order text	Length	Order number
Trigger cable 12-pin HIROSE female to BNC	2.0 m	E1000648
Trigger cable 12-pin HIROSE female to BNC	5.0 m	E1000772
Trigger cable 12-pin HIROSE female to open end	2.0 m	E1000728
Trigger cable 12-pin HIROSE female to open end	10.0 m	E1000736
I/O cable 12-pin HIROSE female to open end	2.0 m	E1000746
I/O cable 12-pin HIROSE female to open end	3.0 m	E1000732

Table 27: Order numbers: trigger and I/O cables

Order text	Length	Order number
I/O cable 12-pin HIROSE female to open end	5.0 m	E1000786
I/O cable 12-pin HIROSE female to open end	10.0 m	E1000749

Table 27: Order numbers: trigger and I/O cables

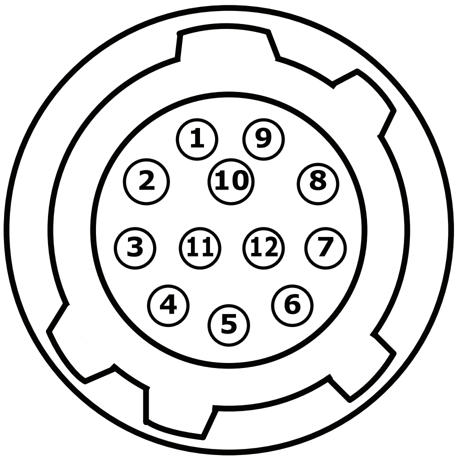


Figure 43: Camera I/O connector pin assignment

Pin	Signal	Direction	Level	Description
1	External GND		GND for RS232 and ext. power	External Ground for RS232 and external power
2	ExtPower		+8...+36 V DC	Power Supply
3	CameraOut4	Out	Open emitter	Camera Output 4 (GPOut4) default: -
4	CameraIn1	In	CMOS / TTL max. 5 V	Camera Input 1 (GPIn1) default: Trigger
5	CameraOut3	Out	Open emitter	Camera Output 3 (GPOut3) default: Busy
6	CameraOut1	Out	Open emitter	Camera Output 1 (GPOut1) default: IntEna

Table 28: Camera I/O connector pinning

Pin	Signal	Direction	Level	Description
7	CameraIn GND	In	Common GND for inputs	Camera Common Input Ground (In GND) See Figure 47: Input Ground (InGND) (Pin no. 7 from camera I/O connector) on page 94
8	RxD_RS232	In	RS232	Terminal Receive Data
9	TxD_RS232	Out	RS232	Terminal Transmit Data
10	CameraOutPower	In	Common VCC for outputs max. 35 V DC	Camera Output Power for digital outputs (OutVCC)
11	CameraIn2	In	CMOS/TTL max. 5 V	Camera Input 2 (GPIn2) default: -
12	CameraOut2	Out	Open emitter	Camera Output 2 (GPOut2) default: -

Table 28: Camera I/O connector pinning

Note

GP = General Purpose

Note

Pin 1 is **not** internally bridged with pin 7 to avoid ground noise being induced in the camera and to prevent ground loops. Use pin 1 only if you want to power the camera by HIROSE or to connect to the serial interface of the camera in combination with pin 8 and 9.

Status LEDs

On LED (green)

The green power LED indicates that the camera is being supplied with sufficient voltage and is ready for operation.

Status LED

The following states are displayed via the LED:

State	Description
Com/S1 (green)	Asynchronous and isochronous data transmission active (indicated asynchronously to transmission via the 1394 bus)
Trg/S2 (yellow)	LED on - waiting for external trigger LED off - triggered / internal sync

Table 29: LED indication

Blink codes are used to signal warnings or error states:

Class S1 → Error code S2 ↓	Warning 1 blink	DCAM 2 blinks	MISC 3 blinks	FPGA 4 blinks	Stack 5 blinks
FPGA boot error				1-5 blinks	
Stack setup					1 blink
Stack start					2 blinks
No FLASH object			1 blink		
No DCAM object		1 blink			
Register mapping		3 blinks			
VMode_ERROR_STATUS	1 blink				
FORMAT_7_ERROR_1	2 blinks				
FORMAT_7_ERROR_2	3 blinks				

Table 30: Error codes

The following sketch illustrates the series of blinks for a Format_7_error_1:

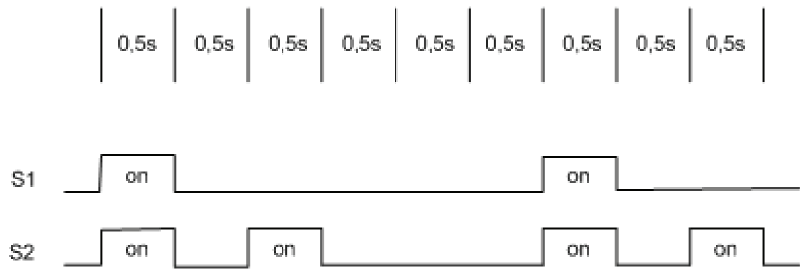


Figure 44: Warning and error states

You should wait for at least 2 full cycles because the display of blinking codes starts asynchronously - e.g. on the second blink from S2.

Operating the camera

Power for the camera is supplied either via the FireWire™ bus or the camera I/O connector's pin 2.

The input voltage must be within the following range:

Vcc min.: +8 V

Vcc max.: +36 V

Note

- An input voltage of 12 V is recommended for most efficient use of the camera
- As mentioned above: The camera I/O supplies power to the camera via a diode. This means that there is no power out at pin 2 if the camera is powered via the bus. Consult the factory if you need power output at this pin instead of power in.

Control and video data signals

The camera has 2 inputs and 4 outputs. These can be configured by software. The different modes are described below.

Inputs

All inputs have been implemented as shown in the diagram below.

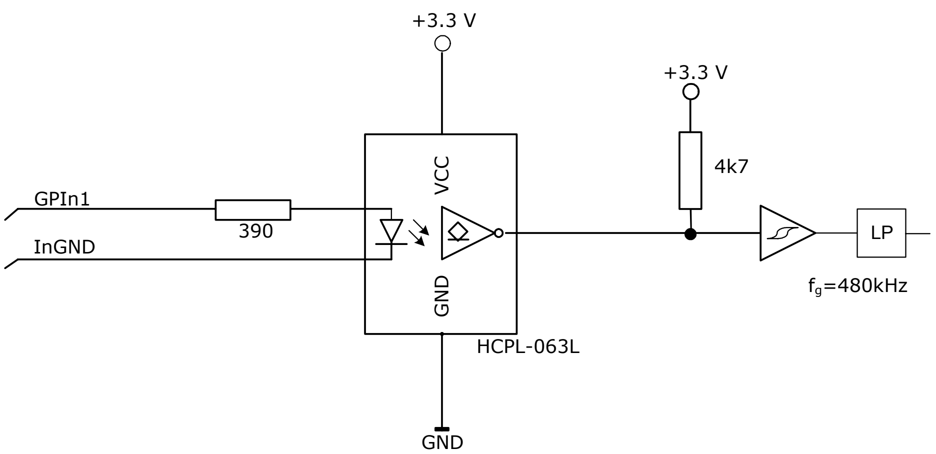


Figure 45: Input schematics

Flux voltage from LED type 1.5 V at 10 mA	
Initial on-current:	5 mA
Max. off-current:	0.25 mA
Max. input current:	15 mA
Min. pulse width	2.2 µs

Table 31: Input characteristics: Flux voltage

Cycle delay of the optocoupler	
tpdLH:	2275 ns
tpdHL:	2290 ns

Table 32: Input characteristics: Cycle delay

The inputs can be connected directly to +5 V. If a higher voltage is used, an external resistor must be placed in series. Use at +12 V a 820 Ω resistor and at +24 V a 2.2 kΩ resistor.

Caution Voltages above +45 V may damage the optical coupler.

The optocoupler inverts all input signals. Inversion of the signal is controlled via the IO_INP_CTRL1..2 register (see Table 33: Input configuration register on page 95).

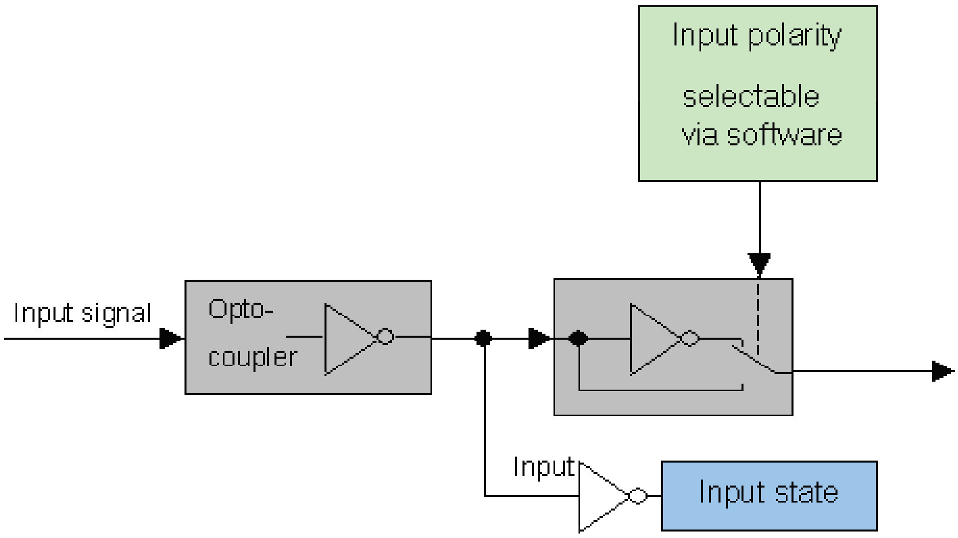


Figure 46: Input block diagram

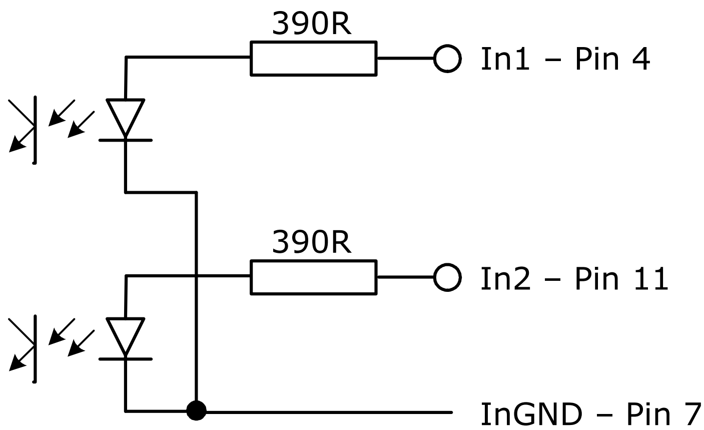


Figure 47: Input Ground (InGND) (Pin no. 7 from camera I/O connector)

Triggers

All inputs configured as triggers are linked by AND. If several inputs are being used as triggers, a high signal must be present on all inputs in order to generate a trigger signal. Each signal can be inverted. The camera must be set to **external triggering** to trigger image capture by the trigger signal.

Input/output pin control

All input and output signals running over the camera I/O connector are controlled by an advanced feature register.

Register	Name	Field	Bit	Description
0xF1000300	IO_INP_CTRL1	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..6]	Reserved
		Polarity	[7]	0: Signal not inverted 1: Signal inverted
		---	[8..10]	Reserved
		InputMode	[11..15]	Mode see Table 34: Input routing on page 96
		---	[16..30]	Reserved
		PinState	[31]	RD: Current state of pin
0xF1000304	IO_INP_CTRL2	Same as IO_INP_CTRL1		

Table 33: Input configuration register

IO_INP_CTRL 1-2

The **Polarity** flag determines whether the input is low active (0) or high active (1). The **input mode** can be seen in the following table. The **PinState** flag is used to query the current status of the input.

The **PinState** bit reads the inverting optocoupler status after an internal negation. See Figure 46: Input block diagram on page 94.

This means that an open input sets the **PinState** bit to **0**. (This is different to AVT Marlin/Dolphin/Oscar, where an open input sets **PinState** bit to **1.**)

ID	Mode	Default
0x00	Off	
0x01	Reserved	
0x02	Trigger input	Input 1
0x03	Reserved	
0x06	Sequence Step	
0x07	Sequence Reset	
0x08..0x1F	Reserved	

Table 34: Input routing

Note

If you set more than 1 input to function as a trigger input, all trigger inputs are ANDed.

Trigger delay

The cameras feature various ways to delay image capture based on external trigger.

With IIDC V1.31 there is a standard CSR at Register F0F00534/834h to control a delay up to FFFh x time base value. The following table explains the inquiry register and the meaning of the various bits.

Register	Name	Field	Bit	Description
0xF0F00534	TRIGGER_DELAY_INQUIRY	Presence_Inq	[0]	Indicates presence of this feature (read only)
		Abs_Control_Inq	[1]	Capability of control with absolute value
		-	[2]	Reserved
		One_Push_Inq	[3]	One-push auto mode (controlled automatically by the camera once)
		Readout_Inq	[4]	Capability of reading out the value of this feature
		ON_OFF	[5]	Capability of switching this feature ON and OFF
		Auto_Inq	[6]	Auto mode (controlled automatically by the camera)
		Manual_Inq	[7]	Manual mode (controlled by user)
		Min_Value	[8..19]	Minimum value for this feature
		Max_Value	[20..31]	Maximum value for this feature

Table 35: Trigger delay inquiry register

Register	Name	Field	Bit	Description
0xF0F00834	TRIGGER_DELAY	Presence_Inq	[0]	Presence of this feature: 0:N/ 1: Available
		Abs_Control	[1]	Absolute value control 0: Control with value in the value field 1: Control with value in the absolute value CSR. If this bit=1 the value in the value field has to be ignored.
		-	[2..5]	Reserved
		ON_OFF	[6]	Write ON or OFF this feature, ON=1 Read: Status of the feature; OFF=0
		-	[7..19]	Reserved
		Value	[20..31]	Value

Table 36: Trigger Delay CSR

The cameras also have an advanced register which allows even more precise image capture delay after receiving a hardware trigger.

Trigger delay advanced register

Register	Name	Field	Bit	Description
0xF1000400	TRIGGER_DELAY	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	-
		ON_OFF	[6]	Trigger delay on/off
		---	[7..10]	-
		DelayTime	[11..31]	Delay time in µs

Table 37: Trigger Delay Advanced CSR

The advanced register allows the start of the integration to be delayed by max. 2^{21} µs, which is max. 2.1 s after a trigger edge was detected.

Note

- Switching trigger delay to ON also switches external Trigger_Mode_0 to ON.
- This feature works with external Trigger_Mode_0 only.

Outputs

The camera has 4 non-inverting outputs with open emitters. These are shown in the following diagram:

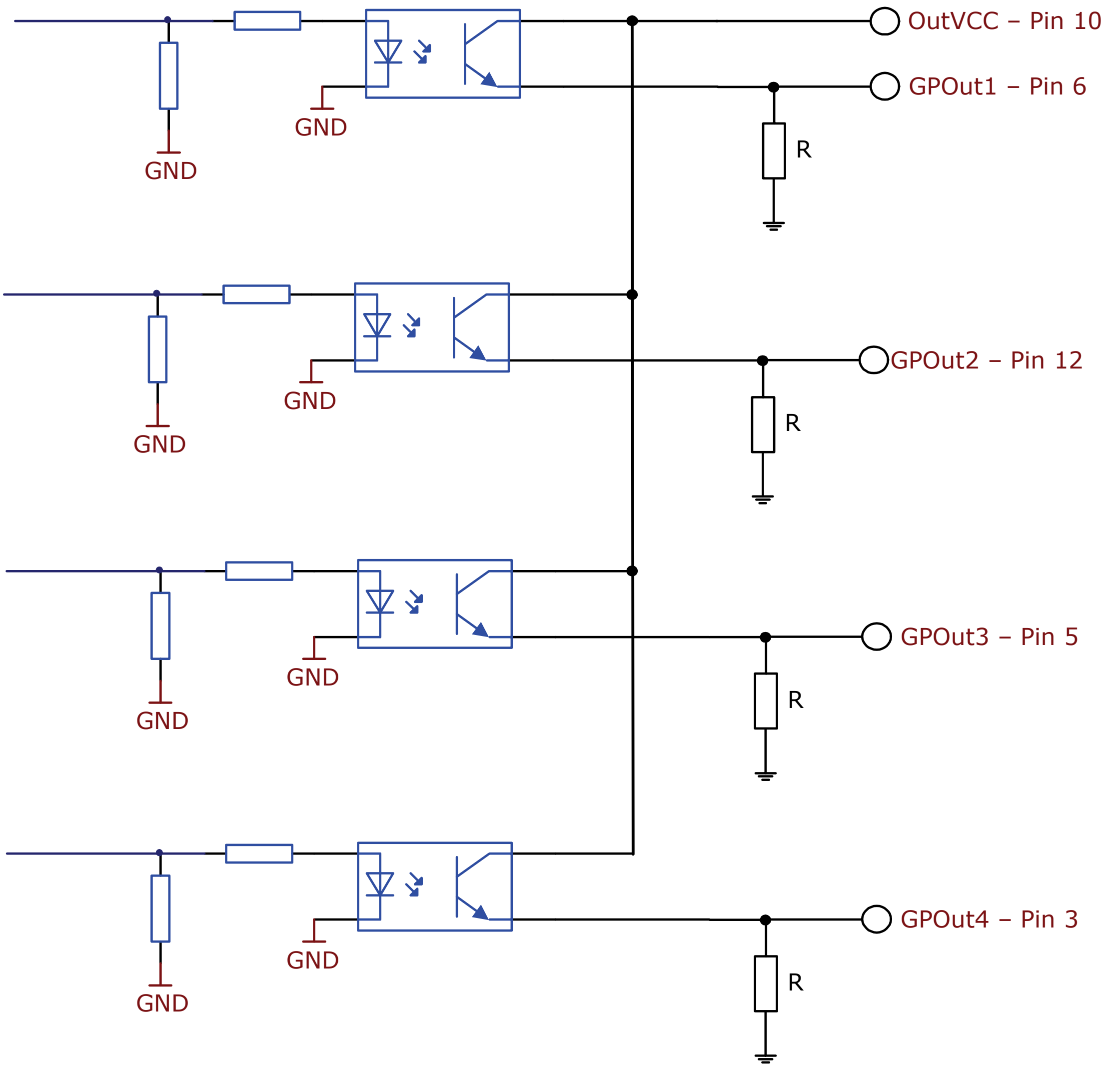


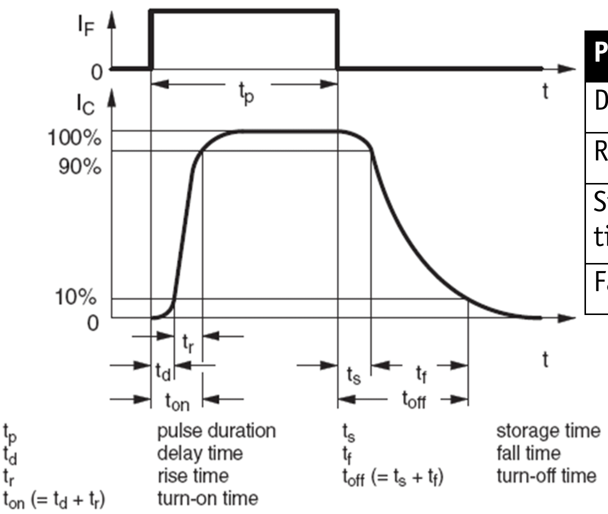
Figure 48: Output schematics with external resistors R (pin no. from camera I/O connector)

Parameter	Test condition	Value
Collector emitter voltage		Max. 35 V
Emitter collector voltage		Max. 7 V
Emitter current		Max. 50 mA
Collector current		Max. 80 mA
Collector peak current	$t_p/T=0.5$ $t_p \leq 10\,ms$	100 mA
Power dissipation		100 mW

OutVCC	Resistor value
5 V	1 kΩ
12 V	2.4 kΩ
24 V	4.7 kΩ

Note

- Voltage above +45 V may damage the optical coupler.
- The output connection is different to the AVT Dolphin series to achieve higher output swing.
- Depending on the voltage applied at OutVCC and the type of input which you want to drive, it may be necessary to switch an external resistor in series between GPOut1...4 and ground.
  See Figure 48: Output schematics with external resistors R (pin no. from camera I/O connector) on page 99.
- Typical delay is not more than 40 µs.
- Pike cameras have the new optocoupler **TLP281-4** from serial no. 101077005 on.



Parameter	Symbol	Value	Condition
Delay time	t_d	0.70 µs	OutVCC = 5 V Resistor value=1 kΩ
Rise time	t_r	0.56 µs	
Storage time	t_s	35.00 µs	
Fall time	t_f	12.00 µs	

Figure 49: Output schematics: switching times

Output features are configured by software. Any signal can be placed on any output.

The main features of output signals are described below:

Signal	Description
IntEna (Integration Enable) signal	This signal displays the time in which exposure was made. By using a register this output can be delayed by up to 1.05 seconds.
Fval (Frame valid) signal	This feature signals readout from the sensor. This signal Fval follows IntEna.
Busy signal	This indicator appears when the exposure is being made; the sensor is being read from or data transmission is active. The camera is busy.

Table 38: Output signals

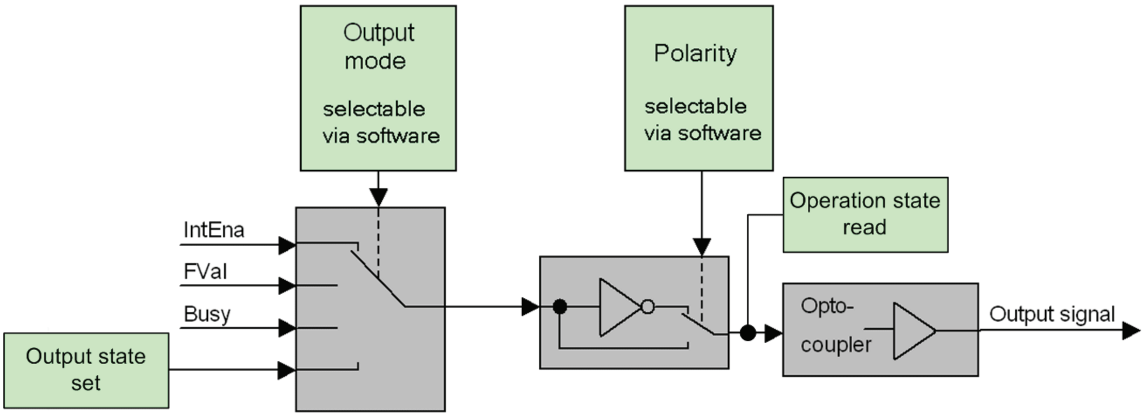


Figure 50: Output block diagram

IO_OUTP_CTRL 1-4

The outputs (Output mode, Polarity) are controlled via 4 advanced feature registers (see Table 39: Output configuration register on page 103).

The **Polarity** field determines whether the output is inverted or not. The **output mode** can be viewed in the table below. The current status of the output can be queried and set via the **PinState**.

It is possible to read back the status of an output pin regardless of the output mode. This allows for example the host computer to determine if the camera is busy by simply polling the BUSY output.

Register	Name	Field	Bit	Description
0xF1000320	IO_OUTP_CTRL1	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..6]	Reserved
		Polarity	[7]	0: Signal not inverted 1: Signal inverted
		---	[8..10]	Reserved
		Output mode	[11..15]	Mode see Table 40: Output routing *on page 104*
		---	[16..30]	Reserved
		PinState	[31]	RD: Current state of pin WR: New state of pin
0xF1000324	IO_OUTP_CTRL2	Same as IO_OUTP_CTRL1		
0xF1000328	IO_OUTP_CTRL3	Same as IO_OUTP_CTRL1		
0xF100032C	IO_OUTP_CTRL4	Same as IO_OUTP_CTRL1		

Table 39: Output configuration register

Output modes

ID	Mode	Default / description
0x00	Off	
0x01	Output state follows **PinState** bit	Using this mode, the Polarity bit has to be set to 0 (not inverted). This is necessary for an error free display of the output status.
0x02	Integration enable	Output 1
0x03	Reserved	
0x04	Reserved	
0x05	Reserved	
0x06	FrameValid	
0x07	Busy	Output 2
0x08	Follow corresponding input (Inp1→ Out1, Inp2 → Out2)	
0x09..0x0F	Reserved	
0x10..0x1F	Reserved	

Table 40: Output routing

PinState 0 switches off the output transistor and produces a low level over the resistor connected from the output to ground.

The following diagram illustrates the dependencies of the various output signals.

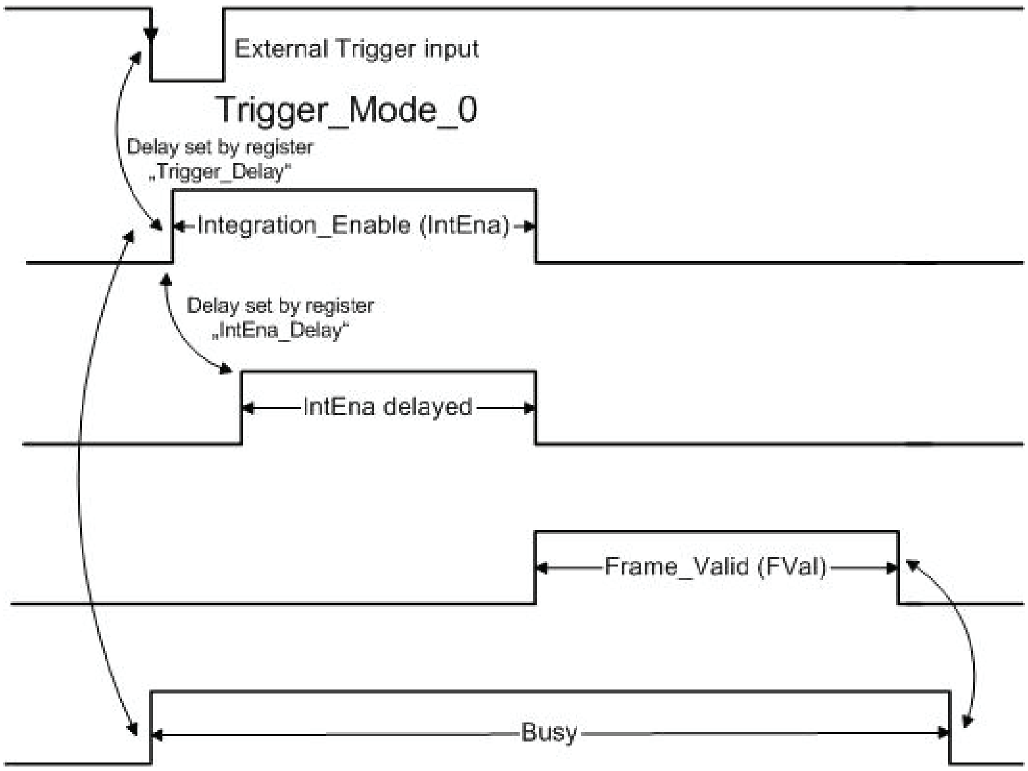


Figure 51: Output impulse diagram

Note

The signals can be inverted.

Caution

Firing a new trigger while **IntEna** is still active can result in **missing image**.

Note

- Note that **trigger delay** in fact delays the image capture whereas the **IntEna_Delay** only delays the leading edge of the IntEna output signal but does not delay the image capture.
- As mentioned before, it is possible to set the outputs by software. Doing so, the achievable maximum frequency is strongly dependent on individual software capabilities. As a rule of thumb, the camera itself will limit the toggle frequency to not more than 700 Hz.

Pixel data

Pixel data are transmitted as isochronous data packets in accordance with the 1394 interface described in IIDC V1.31. The first packet of a frame is identified by the **1** in the **sync bit** (sy) of the packet header.

sync bit

<table>
<tr><td colspan="2">0-7</td><td colspan="2">8-15</td><td colspan="2">16-23</td><td colspan="2">24-31</td></tr>
<tr><td colspan="4">data_length</td><td>tg</td><td>channel</td><td>tCode</td><td>sy</td></tr>
<tr><td colspan="8">header_CRC</td></tr>
<tr><td colspan="8">Video data payload</td></tr>
<tr><td colspan="8">data_CRC</td></tr>
</table>

Table 41: Isochronous data block packet format. Source: IIDC V1.31

Field	Description
data_length	Number of bytes in the data field
tg	**Tag field** shall be set to zero
channel	**Isochronous channel number**, as programmed in the iso_channel field of the cam_sta_ctrl register
tCode	**Transaction code** shall be set to the isochronous data block packet tCode
sy	**Synchronization value (sync bit)** This is one single bit. It indicates the start of a new frame. It shall be set to 0001h on the first isochronous data block of a frame, and shall be set to zero on all other isochronous blocks
Video data payload	Shall contain the digital video information

Table 42: Description of data block packet format

- The video data for each pixel are output in either 8-bit or 14-bit format (**Packed 12-Bit Mode**: 12-bit format).
- Each pixel has a range of 256 or 16384 (**Packed 12-Bit Mode**: 4096) shades of gray.
- The digital value 0 is black and 255 or 16383 (**Packed 12-Bit Mode**: 4095) is white. In 16-bit mode the data output is MSB aligned.

The following table provides a description of the video data format for the different modes. (Source: IIDC V1.31; packed 12-bit mode: AVT)

<YUV (4: 2: 2) format >

U-(K+0)	Y-(K+0)	V-(K+0)	Y-(K+1)
U-(K+2)	Y-(K+2)	V-(K+2)	Y-(K+3)
U-(K+4)	Y-(K+4)	V-(K+4)	Y-(K+5)
U-(K+Pn-6)	Y-(K+Pn-6)	V-(K+Pn-6)	Y-(K+Pn-5)
U-(K+Pn-4)	Y-(K+Pn-4)	V-(K+Pn-4)	Y-(K+Pn-3)
U-(K+Pn-2)	Y-(K+Pn-2)	V-(K+Pn-2)	Y-(K+Pn-1)

<YUV (4: 1: 1) format >

U-(K+0)	Y-(K+0)	Y-(K+1)	V-(K+0)
Y-(K+2)	Y-(K+3)	U-(K+4)	Y-(K+4)
Y-(K+5)	V-(K+4)	Y-(K+6)	Y-(K+7)
U-(K+Pn-8)	Y-(K+Pn-8)	Y-(K+Pn-7)	V-(K+Pn-8)
Y-(K+Pn-6)	Y-(K+Pn-5)	U-(K+Pn-4)	Y-(K+Pn-4)
Y-(K+Pn-3)	V-(K+Pn-4)	Y-(K+Pn-2)	Y-(K+Pn-1)

Figure 52: YUV 4:2:2 and YUV 4:1:1 format: Source: IIDC V1.31 specification

<Y (Mono) format >

Y-(K+0)	Y-(K+1)	Y-(K+2)	Y-(K+3)
Y-(K+4)	Y-(K+5)	Y-(K+6)	Y-(K+7)
Y-(K+Pn-8)	Y-(K+Pn-7)	Y-(K+Pn-6)	Y-(K+Pn-5)
Y-(K+Pn-4)	Y-(K+Pn-3)	Y-(K+Pn-2)	Y-(K+Pn-1)

< Y (Mono16) format >

High byte	Low byte

Y-(K+0)	Y-(K+1)
Y-(K+2)	Y-(K+3)
Y-(K+Pn-4)	Y-(K+Pn-3)
Y-(K+Pn-2)	Y-(K+Pn-1)

Figure 53: Y8 and Y16 format: Source: IIDC V1.31 specification

<Y (Mono12) format>

Y-(K+0) [11..4]	Y-(K+1) [3..0] Y-(K+0) [3..0]	Y-(K+1) [11..4]	Y-(K+2) [11..4]
Y-(K+3) [3..0] Y-(K+2)[3..0]	Y-(K+3) [11..4]	Y-(K+4) [11..4]	Y-(K+5) [3..0] Y-(K+4)[3..0]
Y-(K+5) [11..4]	Y-(K+6) [11..4]	Y-(K+7) [3..0] Y-(K+6) [3..0]	Y-(K+7) [11..4]

Table 43: **Packed 12-Bit Mode** (mono and raw) Y12 format

<Y, R, G, B>

Each component has 8bit data. The data type is "Unsigned Char".

	Signal level (Decimal)	Data (Hexadecimal)
Highest	255	0xFF
	254	0xFE
	:	:
	1	0x01
Lowest	0	0x00

<U, V>

Each component has 8bit data. The data type is "Straight Binary".

	Signal level (Decimal)	Data (Hexadecimal)
Highest (+)	127	0xFF
	126	0xFE
	:	:
	1	0x81
Lowest	0	0x80
	-1	0x7F
	:	:
	-127	0x01
Highest (-)	-128	0x00

< Y(Mono16) >

Y component has 16bit data. The data type is "Unsigned Short (big-endian)".

Y	Signal level (Decimal)	Data (Hexadecimal)
Highest	65535	0xFFFF
	65534	0xFFFE
	:	:
	1	0x0001
Lowest	0	0x0000

Figure 54: Data structure: Source: IIDC V1.31 specification

<Y(Mono12)>

Y component has 12-bit data. The data type is „unsigned".

Y	Signal level (decimal)	Data (hexadecimal)
Highest	4095	0x0FFF
	4094	0x0FFE
	.	.
	.	.
	1	0x0001
Lowest	0	0x0000

Table 44: Data structure of **Packed 12-Bit Mode** (mono and raw)

Description of the data path

Block diagrams of the cameras

The following diagrams illustrate the data flow and the bit resolution of image data after being read from the CCD sensor chip in the camera. The individual blocks are described in more detail in the following paragraphs.

Black and white cameras

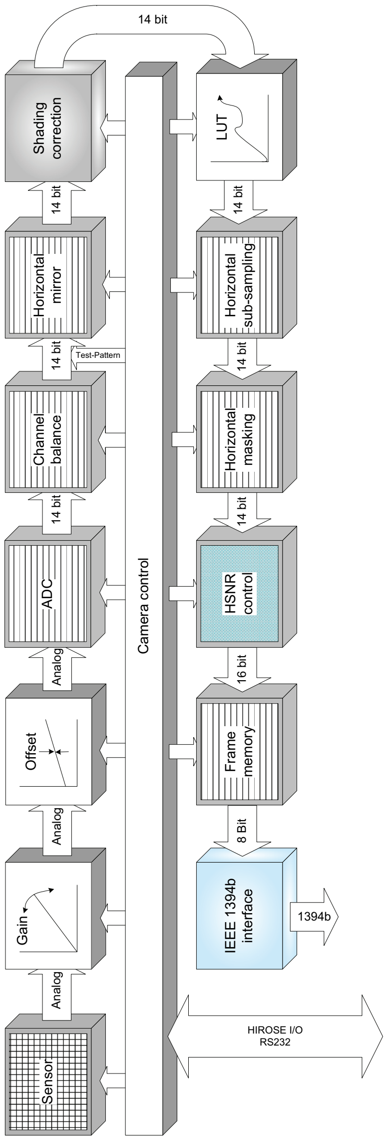


Figure 55: Block diagram b/w camera

Color cameras

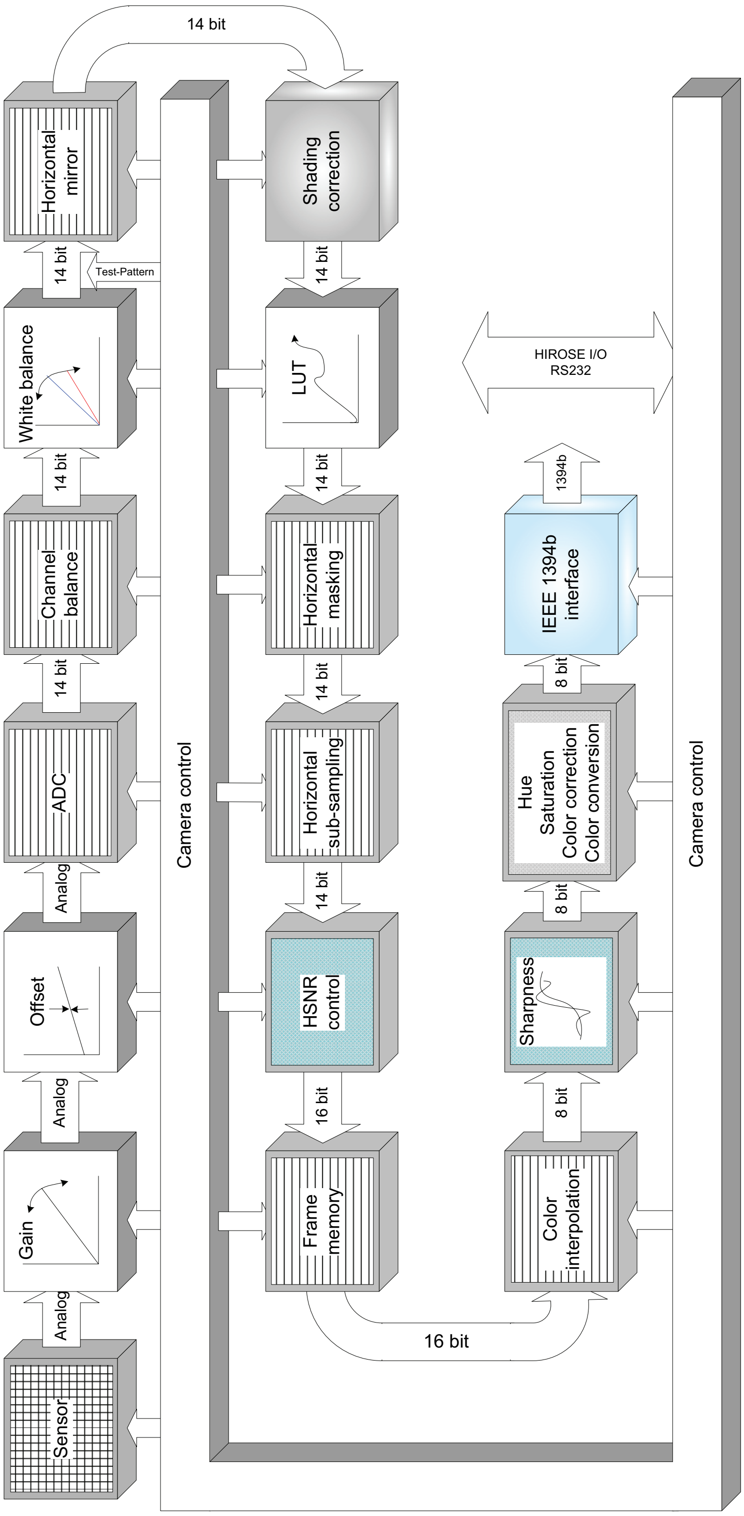


Figure 56: Block diagram color camera

Sensor

The PIKE family is equipped with various sensor types and resolutions. CCD types are available in color and monochrome.

The following table provides an overview (all models also with fiber):

Model	Techn	Manu-facturer	Sensor Type	Optical Format	Sensor diag.	Micro-lens	Chip Size [mm^2]	Pixel Size [μm^2]
PIKE F-032B PIKE F-032C	CCD	KODAK	KAI-340	type 1/3	6 mm	Yes	4.74x3.55	7.4x7.4
PIKE F-100B PIKE F-100C	CCD	KODAK	KAI-1020	type 2/3	10.5 mm	Yes	7.4x7.4	7.4x7.4
PIKE F-145B PIKE F-145C	CCD	SONY	ICX285	type 2/3	11.2 mm	Yes EXview HAD	10.2x8.3	6.45 x 6.45
PIKE F-210B PIKE F-210C	CCD	KODAK	KAI-2093	type 1	15.3 mm	Yes	15.9x8.6	7.4x7.4
PIKE F-421B PIKE F-421C	CCD	KODAK	KAI-4021	type 1.2	21.4 mm	Yes	16.67x16.05	7.4x7.4
PIKE F-505B PIKE F-505C	CCD	SONY	ICX625	type 2/3	11.016 mm	Yes Super HAD	9.93×8.70	3.45x3.45

Table 45: Sensor data

Channel balance

All KODAK PIKE sensors are read out via two channels: the first channel for the left half of the image and the second channel for the right half of the image (divided by a central vertical line).

All KODAK equipped cameras come with a sensor-specific pre-adjusted channel balance.

However in some cases it may be advantageous to carry out a fine adjustment with the so-called channel balance.

To carry out an adjustment in an advanced register: see Table 155: Channel balance register on page 305.

Channel adjustment with SmartView (>1.5)

Prerequisites:

- Test sheet with continuous b/w gradient

- PIKE camera with defocused lens
- PIKE color cameras set to RAW8 and RAW16
- In case of using AOI, be aware that the middle vertical line (+/- 20 pixel) is part of the AOI.

To carry out an adjustment in SmartView, perform the following steps:

1. In SmartView click **Extras** → **Adjust channels...** or use **Alt+Ctrl+A**.

   The following window opens:

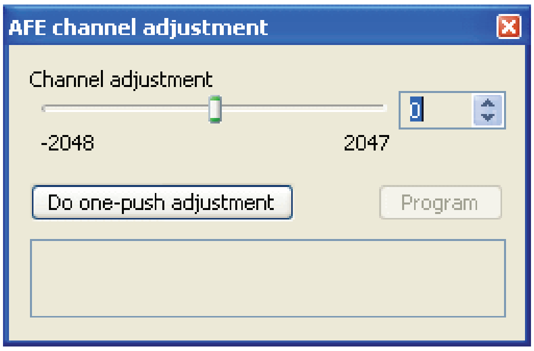


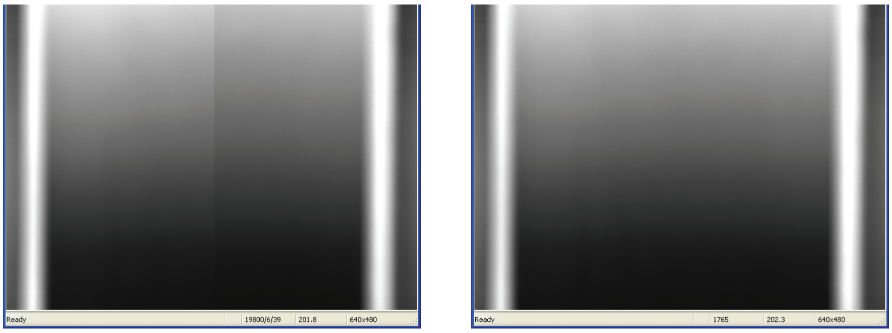
Figure 57: SmartView: channel adjustment

Note

Program button is only available for AVT factory.

2. To perform an automatic channel adjustment, click on **Do one-push adjustment**.
3. If the adjustment is not sufficient, repeat this step or adjust by clicking the arrow buttons.

The two channels are automatically adjusted. For the channel adjustment a region from +/- 20 pixel around the middle vertical is taken into account.



before after

Figure 58: Example of channel adjustment: PIKE F-032B

White balance

PIKE color cameras have both manual and automatic white balance. White balance is applied so that non-colored image parts are displayed non-colored. From the user's point, the white balance settings are made in register 80Ch of IIDC V1.31. This register is described in more detail below.

Register	Name	Field	Bit	Description
0xF0F0080C	WHITE_BALANCE	Presence_Inq	[0]	Presence of this feature: 0: N/A 1: Available
		Abs_Control	[1]	Absolute value control 0: Control with value in the **Value** field 1: Control with value in the **Absolute** value CSR If this bit=1, the value in the **Value** field will be ignored.
		-	[2..4]	Reserved
		One_Push	[5]	Write 1: begin to work (self-cleared after operation) Read: 1: in operation 0: not in operation If A_M_Mode = 1, this bit will be ignored.
		ON_OFF	[6]	Write: ON or OFF this feature Read: read a status 0: OFF 1: ON
		A_M_MODE	[7]	Write: set mode Read: read current mode 0: MANUAL 1: AUTO
		U/B_Value	[8..19]	U/B value This field is ignored when writing the value in Auto or OFF mode. If readout capability is not available, reading this field has no meaning.
		V/R_Value	[20..31]	V/R Value This field is ignored when writing the value in Auto or OFF mode. If readout capability is not available, reading this field has no meaning.

Table 46: White balance register

The values in the U/B_Value field produce changes from green to blue; the V/R_Value field from green to red as illustrated below.

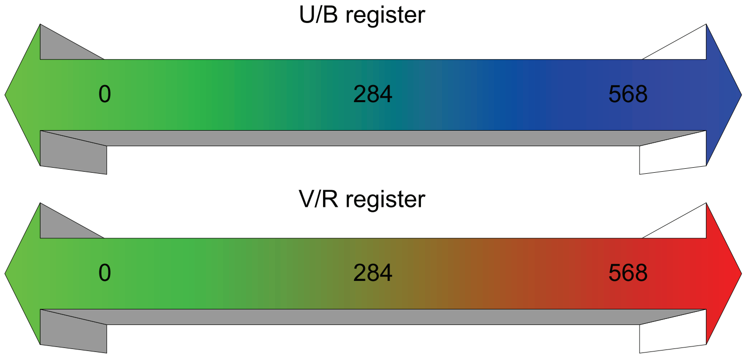


Figure 59: U/V slider range

Type	Range	Range in dB
PIKE color cameras	0 ... 568	± 10 dB

Table 47: Manual gain range of the various PIKE types

The increment length is ~0.0353 dB/step.

One-push automatic white balance

To configure this feature in control and status register (CSR): See Table 46: White balance register on page 115.

The camera automatically generates frames, based on the current settings of all registers (GAIN, OFFSET, SHUTTER, etc.).

For white balance, in total 9 frames are processed. For the white balance algorithm the whole image or a subset of it is used. The R-G-B component values of the samples are added and are used as actual values for both the one-push and the automatic white balance.

This feature uses the assumption that the R-G-B component sums of the samples shall be equal; i.e., it assumes that the average of the sampled grid pixels is to be monochrome.

Note

The following ancillary conditions should be observed for successful white balance:

- There are no stringent or special requirements on the image content, it requires only the presence of monochrome pixels in the image.
- Automatic white balance can be started both during active image capture and when the camera is in idle state.

If the image capture is active (e.g. **IsoEnable** set in register 614h), the frames used by the camera for white balance are also output on the 1394 bus. Any previously active image capture is restarted after the completion of white balance.

Automatic white balance can also be enabled by using an external trigger. However, if there is a pause of >10 seconds between capturing individual frames this process is aborted.

The following flow diagram illustrates the automatic white balance sequence.

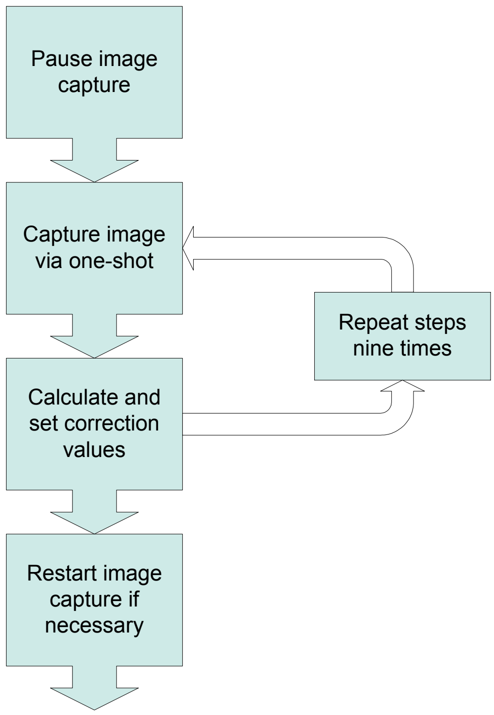


Figure 60: Automatic white balance sequence

Finally, the calculated correction values can be read from the WHITE_BALANCE register 80Ch.

Automatic white balance

The auto white balance feature continuously optimizes the color characteristics of the image.

For the white balance algorithm the whole image or a subset of it is used.

To set position and size of the control area (Auto_Function_AOI) in an advanced register: see Table 151: Advanced register for autofunction AOI on page 301.

AUTOFNC_AOI affects the auto shutter, auto gain and auto white balance features and is independent of the Format7 AOI settings. If this feature is switched off the work area position and size follow the current active image size.

Within this area, the R-G-B component values of the samples are added and used as actual values for the feedback.

The following drawing illustrates the AUTOFNC_AOI settings in greater detail.

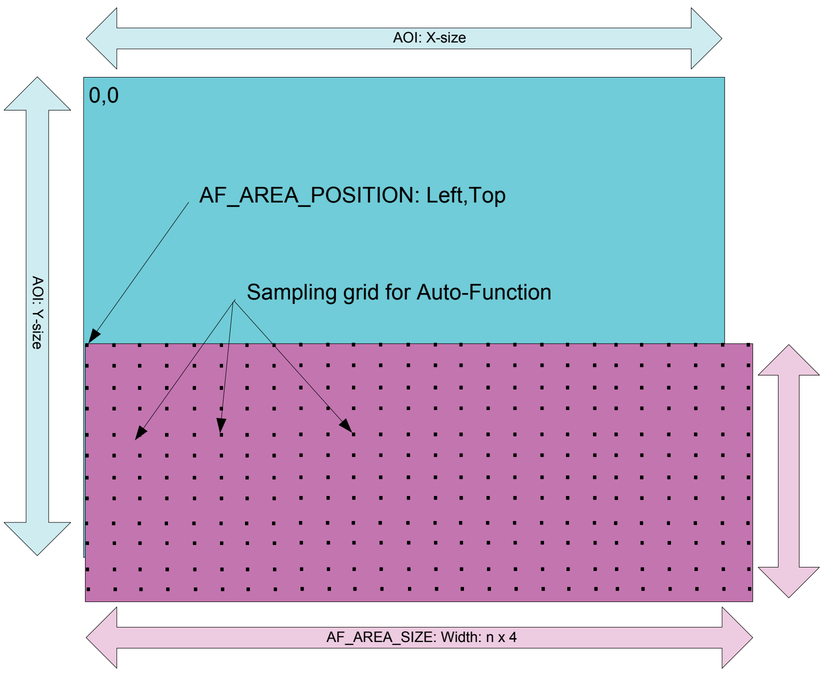


Figure 61: AUTOFNC_AOI positioning

The algorithm is based on the assumption that the R-G-B component sums of the samples are equal, i.e., it assumes that the mean of the sampled grid pixels is to be monochrome.

Auto shutter

In combination with auto white balance, PIKE cameras are equipped with auto-shutter feature.

When enabled, the auto shutter adjusts the shutter within the default shutter limits or within those set in advanced register F1000360h in order to reach the reference brightness set in auto exposure register. **Target grey level** parameter in SmartView corresponds to **Auto_exposure** register 0xF0F00804 (IIDC). Increasing the auto exposure value increases the average brightness in the image and vice versa.

The applied algorithm uses a proportional plus integral controller (PI controller) to achieve minimum delay with zero overshot.

To configure this feature in control and status register (CSR):

Register	Name	Field	Bit	Description
0xF0F0081C	SHUTTER	Presence_Inq	[0]	Presence of this feature: 0: N/A 1: Available
		Abs_Control	[1]	Absolute value control 0: Control with value in the **Value** field 1: Control with value in the **Absolute** value CSR If this bit=1, the value in the **Value** field will be ignored.
		-	[2..4]	Reserved
		One_Push	[5]	Write 1: begin to work (self-cleared after operation) Read: 1: in operation 0: not in operation If A_M_Mode = 1, this bit will be ignored.
		ON_OFF	[6]	Write: ON or OFF this feature Read: read a status 0: OFF 1: ON
		A_M_MODE	[7]	Write: set mode Read: read current mode 0: MANUAL 1: AUTO
		-	[8..19]	Reserved
		Value	[20..31]	Read/Write Value This field is ignored when writing the value in Auto or OFF mode. If readout capability is not available, reading this field has no meaning.

Table 48: Shutter CSR

To configure **auto shutter control** in an advanced register: See Table 149: Auto shutter control advanced register on page 299.

Auto gain

All PIKE cameras are equipped with auto gain feature.

To configure this feature in an advanced register: See Table 150: Advanced register for auto gain control on page 300.

When enabled auto gain adjusts the gain within the default gain limits or within the limits set in advanced register F1000370h in order to reach the brightness set in auto exposure register as reference.

Increasing the auto exposure value increases the average brightness in the image and vice versa.

The applied algorithm uses a proportional plus integral controller (PI controller) to achieve minimum delay with zero overshot.

The following table shows both the gain and auto exposure CSR.

Register	Name	Field	Bit	Description
0xF0F00820	GAIN	Presence_Inq	[0]	Presence of this feature: 0: N/A 1: Available
		Abs_Control	[1]	Absolute value control 0: Control with value in the value field 1: Control with value in the absolute value CSR If this bit=1 the value in the value field has to be ignored.
		-	[2..4]	Reserved
		One_Push	[5]	Write: Set bit high to start Read: Status of the feature: Bit high: WIP Bit low: Ready
		ON_OFF	[6]	Write: ON or OFF this feature Read: read a status 0: OFF 1: ON
		A_M_MODE	[7]	Write: set mode Read: read current mode 0: MANUAL 1: AUTO
		-	[8..19]	reserved
		Value	[20..31]	Read/Write Value This field is ignored when writing the value in Auto or OFF mode. If readout capability is not available, reading this field has no meaning.

Table 49: Gain

Register	Name	Field	Bit	Description
0xF0F00804	AUTO_EXPOSURE	Presence_Inq	[0]	Presence of this feature: 0: N/A 1: Available
		Abs_Control	[1]	Absolute value control 0: Control with value in the value field 1: Control with value in the absolute value CSR If this bit=1 the value in the value field has to be ignored.
		-	[2..4]	Reserved
		One_Push	[5]	Write: Set bit high to star Read: Status of the feature: Bit high: WIP Bit low: Ready
		ON_OFF	[6]	Write: ON or OFF this feature Read: read a status 0: OFF 1: ON
		A_M_MODE	[7]	Write: set mode Read: read current mode 0: MANUAL 1: AUTO
		-	[8..19]	Reserved
		Value	[20..31]	Read/Write Value This field is ignored when writing the value in Auto or OFF mode. If readout capability is not available, reading this field has no meaning.

Table 50: Auto Exposure CSR

To configure auto gain control in an advanced register: See Table 150: Advanced register for auto gain control on page 300.

Note

- Values can only be changed within the limits of gain CSR.
- Changes in auto exposure register only have an effect when auto gain is active.
- Auto exposure limits are 50..205. (**SmartView→Ctrl1 tab: Target grey level**)

Manual gain

PIKE cameras are equipped with a gain setting, allowing the gain to be **manually** adjusted on the fly by means of a simple command register write.

The following ranges can be used when manually setting the gain for the analog video signal:

Type	Range	Range in dB
PIKE color cameras	0 … 565	0 … 20 dB
PIKE b/w cameras	1 … 630	0 … 22 dB
PIKE F-145B	0 … 900	0 … 32 dB
PIKE F-145C	0 … 900	0 … 32 dB
PIKE F-145B-15fps	0 … 900	0 … 32 dB
PIKE F-145C-15fps	0 … 900	0 … 32 dB
PIKE F-505B	0 … 670	0 … 24 dB
PIKE F-505C	0 … 670	0 … 24 dB

Table 51: Manual gain range of the various PIKE types

The increment length is ~0.0353 dB/step.

The increment length for the PIKE F-145B/C is ~0.0358 dB/step.

The increment length for the PIKE F-145B/C-15fps is ~0.0358 dB/step.

The increment length for the PIKE F-505B/C is ~0.0359 dB/step.

Note

- Setting the gain does not change the offset (black value)
- A higher gain produces greater image noise. This reduces image quality. For this reason, try first to increase the brightness, using the aperture of the camera optics and/or longer shutter settings.

Brightness (black level or offset)

It is possible to set the black level in the camera within the following ranges:

0 … +16 gray values (@ 8 bit)

Increments are in 1/16 LSB (@ 8 bit)

Note

- Setting the gain does not change the offset (black value).

The IIDC register brightness at offset 800h is used for this purpose.

The following table shows the BRIGHTNESS register.

Register	Name	Field	Bit	Description
0xF0F00800	BRIGHTNESS	Presence_Inq	[0]	Presence of this feature: 0: N/A 1: Available
		Abs_Control	[1]	Absolute value control 0: Control with value in the value field 1: Control with value in the absolute value CSR If this bit= 1 the value in the value field has to be ignored
		-	[2..4]	Reserved
		One_Push	[5]	Write: Set bit high to start Read: Status of the feature: Bit high: WIP Bit low: Ready
		ON_OFF	[6]	Write ON or OFF this feature ON=1 Read: Status of the feature OFF=0
		A_M_MODE	[7]	Set bit high for Auto feature Read for Mode; 0= MANUAL; 1= AUTO
		-	[8..19]	Reserved
		Value	[20..31]	Read/Write Value; this field is ignored when writing the value in Auto or OFF mode; if readout capability is not available reading this field has no meaning

Table 52: Brightness

Horizontal mirror function

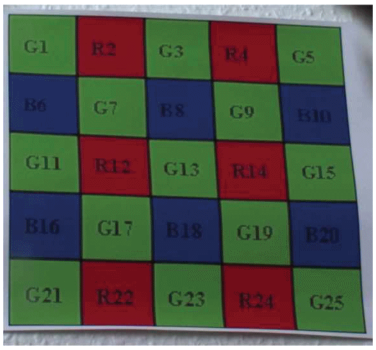
All PIKE cameras are equipped with an electronic mirror function, which mirrors pixels from the left side of the image to the right side and vice versa. The mirror is centered to the actual **FOV** center and can be combined with all image manipulation functions, like **binning**, **shading** and **DSNU**.

This function is especially useful when the camera is looking at objects with the help of a mirror or in certain microscopy applications.

To configure this feature in an advanced register: See Table 154: Mirror control register on page 304.

Note

The use of the mirror function with color cameras and image output in RAW format has implications on the BAYER-ordering of the colors.



Mirror OFF: R-G-G-B for Pike 145C

Mirror OFF: G-R-G-B for all other Pikes

Mirror ON: G-R-B-G Pike 145 C

Mirror ON: R-G-G-B for all other Pikes

Figure 62: Mirror and Bayer order

Note

During switchover one image may be temporarily corrupted.

Shading correction

Shading correction is used to compensate for non-homogeneities caused by lighting or optical characteristics within specified ranges.

To correct a frame, a multiplier from 1...2 is calculated for each pixel in 1/256 steps: this allows for shading to be compensated by up to 50%.

Besides generating shading data off-line and downloading it to the camera, the camera allows correction data to be generated automatically in the camera itself.

Note

- Shading correction does not support the mirror function.
- If you use shading correction, don't change the mirror function.
- Due to binning and sub-sampling in the Format_7 modes read the following hints to build shading image in Format_7 modes.

Building shading image in Format_7 modes

horizontal Binning/sub-sampling is always done after shading correction. Shading is always done on full horizontal resolution. Therefore shading image has always to be built in **full horizontal resolution**.

vertical Binning/sub-sampling is done in the sensor, before shading correction. Therefore shading image has to be built in the **correct vertical resolution**.

Note

Build shading image always with the **full horizontal resolution** (0 x horizontal binning / 0 x horizontal sub-sampling), but with the **desired vertical binning/sub-sampling**.

First example

4 x horizontal binning, 2 x vertical binning
⇨ build shading image with 0 x horizontal binning and 2 x vertical binning

Second example

2 out of 16 horizontal sub-sampling, 2 out of 8 vertical sub-sampling
⇨ build shading image with 0 x horizontal binning and 2 out of 8 vertical sub-sampling

How to store shading image

There are two storing possibilities:

- After generating the shading image in the camera, it can be uploaded to the host computer for nonvolatile storage purposes.
- The shading image can be stored in the camera itself.

The following pictures describe the process of automatic generation of correction data (PIKE F-032C). Surface plots and histograms were created using the **ImageJ** program.

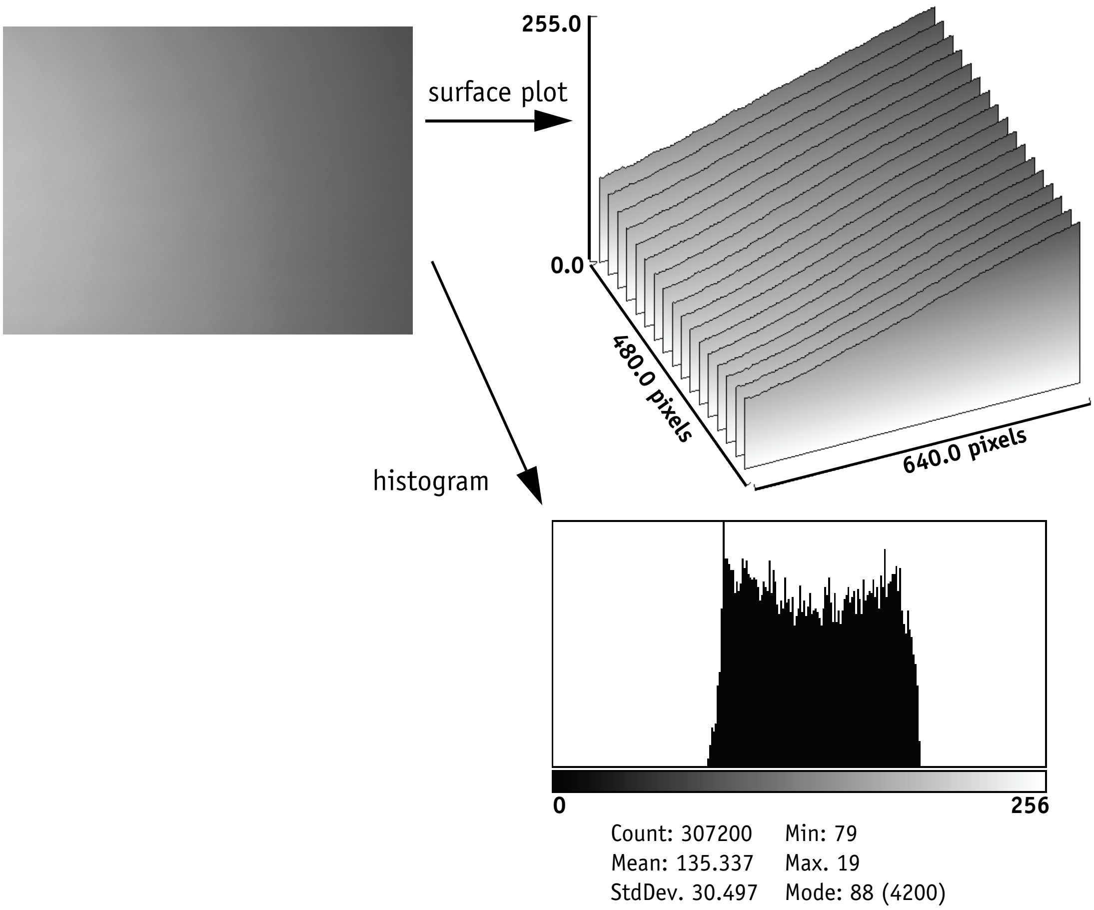


Figure 63: Shading correction: Source image with non-uniform illumination

- On the left you see the source image with non-uniform illumination.
- The surface plot on the right clearly shows a gradient of the brightness (0: brightest → 255: darkest pixels).
- The histogram shows a wide band of gray values.

By defocusing the lens, high-frequency image data is removed from the source image, therefore its not included in the shading image.

Automatic generation of correction data

Requirements

Shading correction compensates for non-homogeneities by giving all pixels the same gray value as the brightest pixel. This means that only the background must be visible and the brightest pixel has a gray value of less than 255 when automatic generation of shading data is started.

It may be necessary to use a neutral white reference, e.g. a piece of paper, instead of the real image.

Algorithm

After the start of automatic generation, the camera pulls in the number of frames set in the GRAB_COUNT register. Recommended values are 2, 4, 8, 16, 32, 64, 128 or 256. An arithmetic mean value is calculated from them (to reduce noise).

After this, a search is made for the brightest pixel in the mean value frame. The brightest pixel(s) remain unchanged. A factor is then calculated for each pixel to be multiplied by, giving it the gray value of the brightest pixel.

All of these multipliers are saved in a **shading reference image**. The time required for this process depends on the number of frames to be calculated and on the resolution of the image.

Correction alone can compensate for shading by up to 50% and relies on full resolution data to minimize the generation of missing codes.

How to proceed:

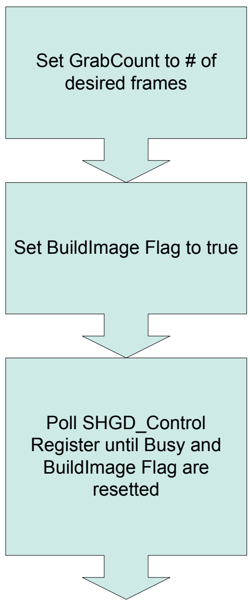


Figure 64: Automatic generation of a shading image

To configure this feature in an advanced register: See Table 144: Shading control register on page 293.

Note

- The SHDG_CTRL register should not be queried at very short intervals. This is because each query delays the generation of the shading image. An optimal interval time is 500 ms.

Note

- The calculation of shading data is always carried out at the current resolution setting. If the AOI is later larger than the window in which correction data was calculated, none of the pixels lying outside are corrected.
- For Format_7 mode, it is advisable to generate the shading image in the largest displayable frame format. This ensures that any smaller AOIs are completely covered by the shading correction.
- The automatic generation of shading data can also be enabled when image capture is already running. The camera then pauses the running image capture for the time needed for generation and resumes after generation is completed.
- Shading correction can be combined with the image mirror and gamma functionality.
- Changing binning modes involves the generation of new shading reference images due to a change in the image size.

After the lens has been focused again the image below will be seen, but now with a considerably more uniform gradient.

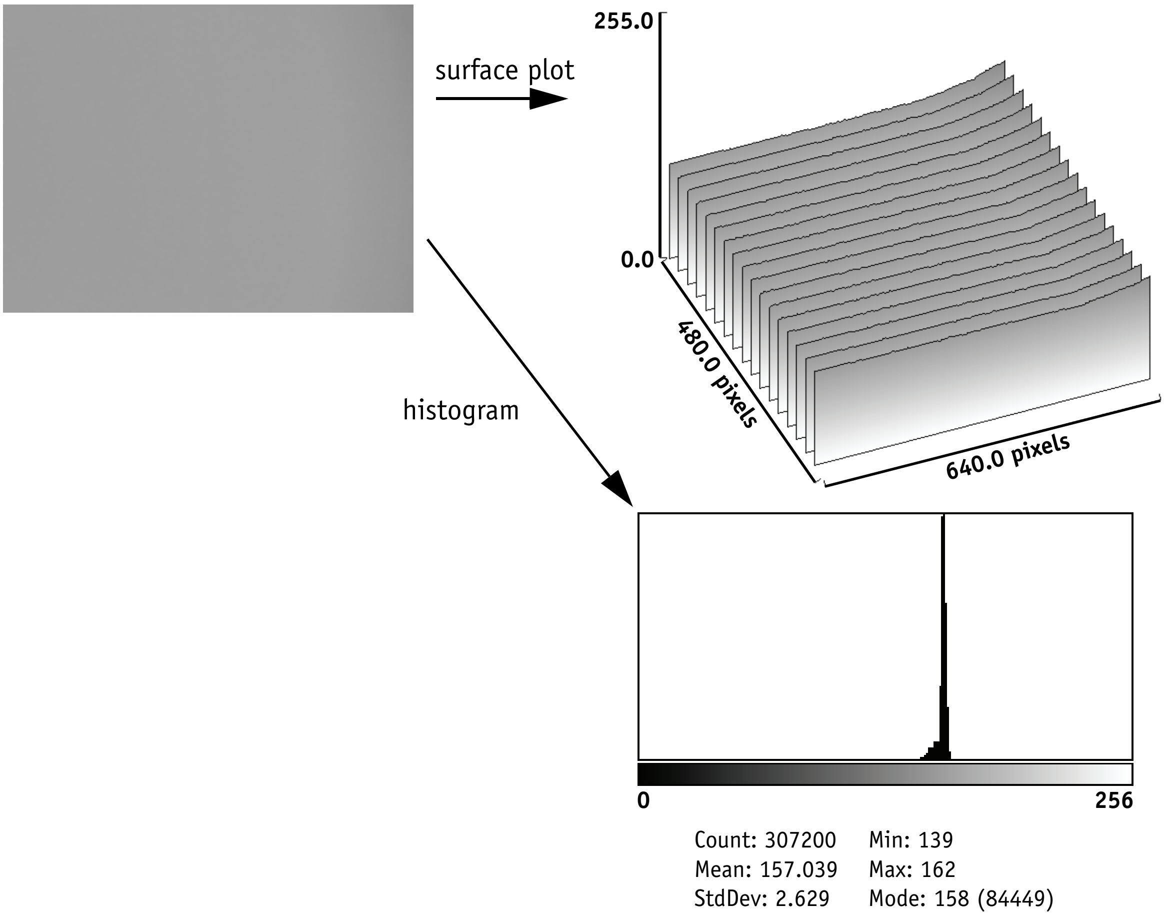


Figure 65: Example of shaded image

- On the left you see the image after shading correction.
- The surface plot on the right clearly shows nearly no more gradient of the brightness (0: brightest → 255: darkest pixels). The remaining gradient is related to the fact that the source image is lower than 50% on the right hand side.
- The histogram shows a peak with very few different gray values.

Loading a shading image out of the camera

GPDATA_BUFFER is used to load a shading image out of the camera. Because the size of a shading image is larger than GPDATA_BUFFER, input must be handled in several steps:

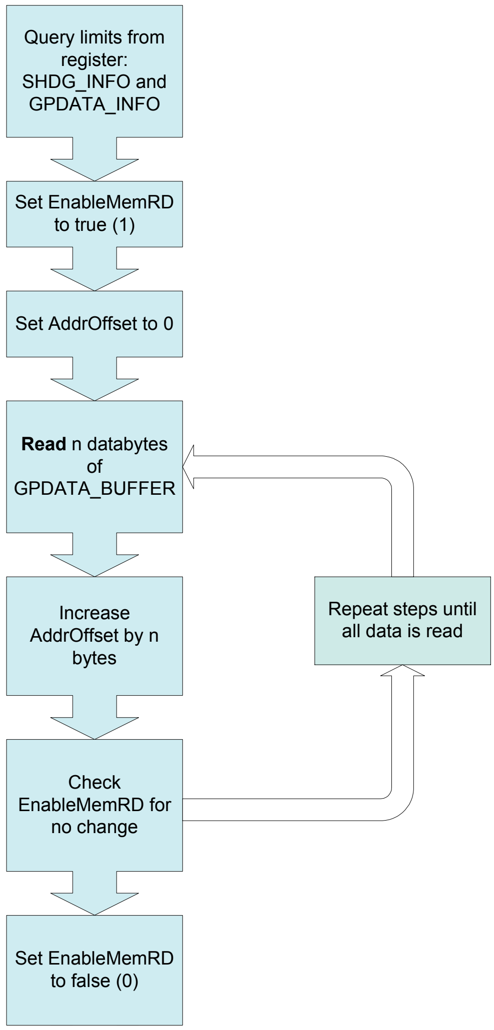


Figure 66: Uploading shading image to host

Loading a shading image into the camera

GPDATA_BUFFER is used to load a shading image into the camera. Because the size of a shading image is larger than GPDATA_BUFFER, input must be handled in several steps (see also Chapter Reading or writing shading image from/into the camera on page 294):

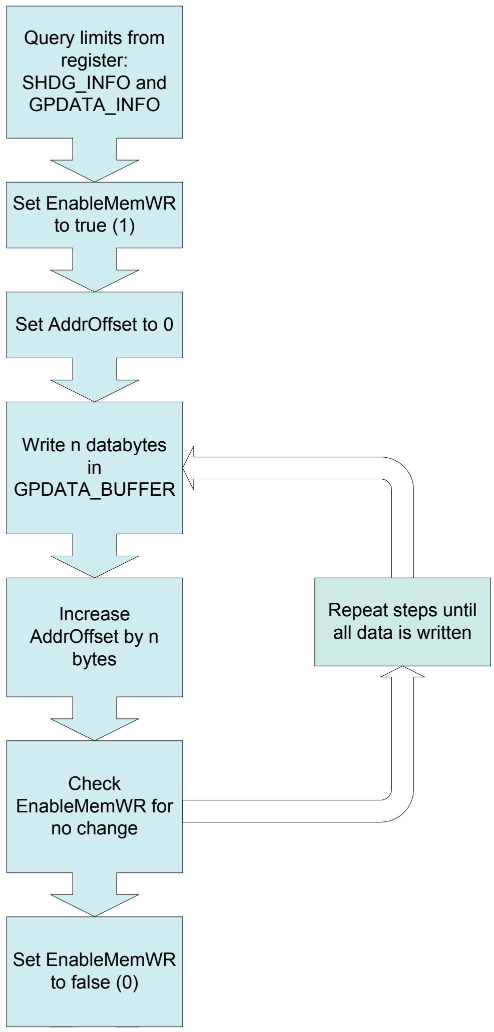


Figure 67: Loading the shading reference image

Look-up table (LUT) and gamma function

The AVT PIKE camera provides sixteen (0-15) user-defined look-up tables (LUT). The use of one LUT allows any function (in the form Output = F(Input)) to be stored in the camera's RAM and to be applied on the individual pixels of an image at run-time.

The address lines of the RAM are connected to the incoming digital data, these in turn point to the values of functions which are calculated offline, e.g. with a spreadsheet program.

This function needs to be loaded into the camera's RAM before use.

One example of using an LUT is the gamma LUT:

There are two gamma LUTs (gamma=0.7 and gamma=0.45)

Output = $(\text{Input})^{0.7}$ and Output = $(\text{Input})^{0.45}$

These two gamma LUTs are used with all PIKE models.

It is known as compensation for the nonlinear brightness response of many displays e.g. CRT monitors. The look-up table converts the incoming 14 bits from the digitizer to outgoing up to 14 bits.

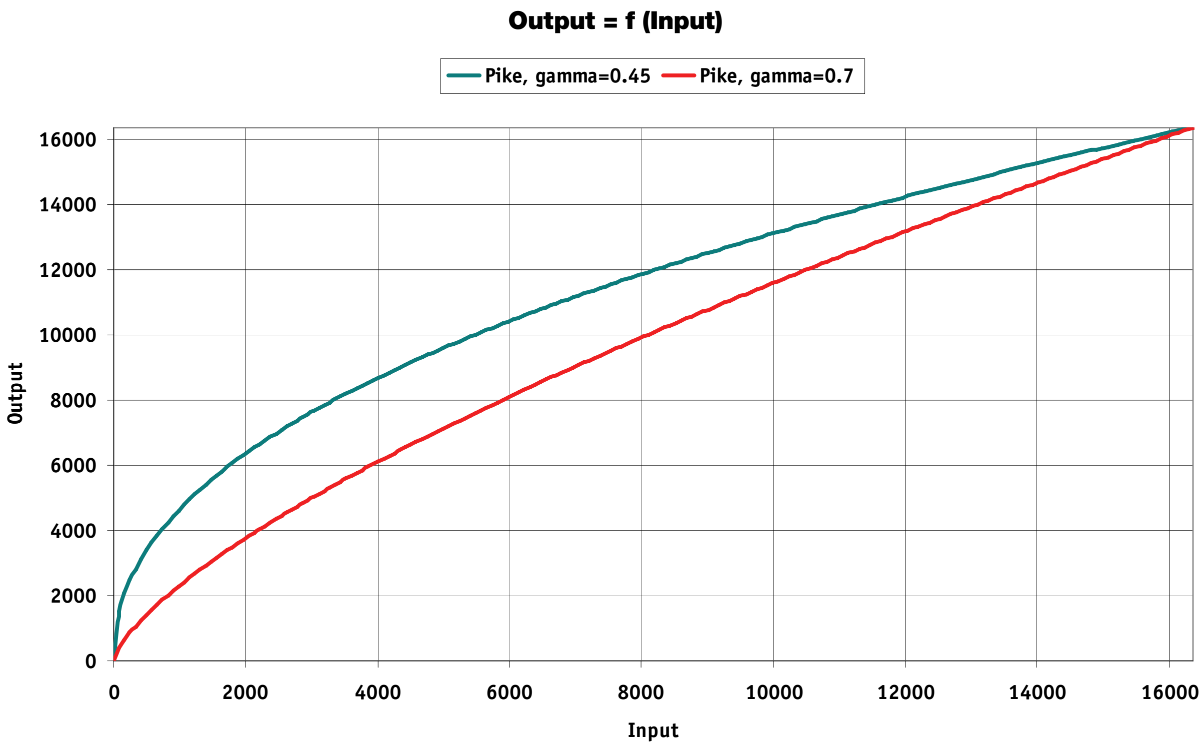


Figure 68: LUTs with gamma=0.45, gamma=0.7

Note

- The input value is the 14-bit value from the digitizer.
- The two gamma LUTs use LUT 14 and 15.
- Gamma 1 (gamma=0.7) switches on LUT 14, gamma 2 (gamma=0.45) switches on LUT 15. After overriding LUT 14 and 15 with a user defined content, gamma functionality is no longer available until the next full initialization of the camera.
- LUT content is volatile if you do not use the user profiles to save the LUT.

Loading an LUT into the camera

Loading the LUT is carried out through the data exchange buffer called GPDATA_BUFFER. As this buffer can hold a maximum of 2 kB, and a complete LUT at 16384 x 14 bit is 28 kByte, programming can not take place in a one block write step because the size of an LUT is larger than GPDATA_BUFFER. Therefore input must be handled in several steps. The flow diagram below shows the sequence required to load data into the camera.

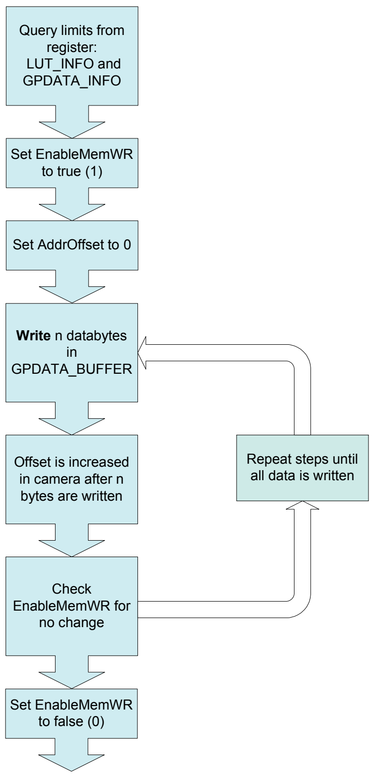


Figure 69: Loading an LUT

To configure this feature in an advanced register: See Table 143: LUT control register on page 290.

Binning (only PIKE b/w models)

2 x / 4 x / 8 x binning

Definition

Binning is the process of combining neighboring pixels while being read out from the CCD chip.

Note

- Only **PIKE b/w cameras** have this feature.
- Binning does not change offset, brightness or black-level.

Binning is used primarily for 3 reasons:

- a reduction in the number of pixels and thus the amount of data while retaining the original image area angle
- an increase in the frame rate (vertical binning only)
- a brighter image, also resulting in an improvement in the signal-to-noise ratio of the image

Signal-to-noise ratio (SNR) and **signal-to-noise separation** specify the quality of a signal with regard to its reproduction of intensities. The value signifies how high the ratio of noise is in regard to the maximum achievable signal intensity.

The higher this value, the better the signal quality. The unit of measurement used is generally known as the decibel (dB), a logarithmic power level. 6 dB is the signal level at approximately a factor of 2.

However, the advantages of increasing signal quality are accompanied by a reduction in resolution.

Only Format_7

Binning is possible only in video Format_7. The type of binning used depends on the video mode.

Note

Changing binning modes involves the generation of new shading reference images due to a change in the image size.

Types

In general, we distinguish between six types of binning (H=horizontal, V=vertical):

- 2 x H-binning
- 2 x V-binning
- 4 x H-binning
- 4 x V-binning
- 8 x H-binning
- 8 x V-binning

and the full binning modes:

- 2 x full binning (a combination of 2 x H-binning and 2 x V-binning)
- 4 x full binning (a combination of 4 x H-binning and 4 x V-binning)
- 8 x full binning (a combination of 8 x H-binning and 8 x V-binning)

Vertical binning

Vertical binning increases the light sensitivity of the camera by a factor of two (4 or 8) by adding together the values of two (4 or 8) adjoining vertical pixels output as a single pixel. This is done directly in the horizontal shift register of the sensor.

Format_7 Mode_2

By default and without further remapping use **Format_7 Mode_2** for 2 x vertical binning.

This reduces vertical resolution, depending on the model.

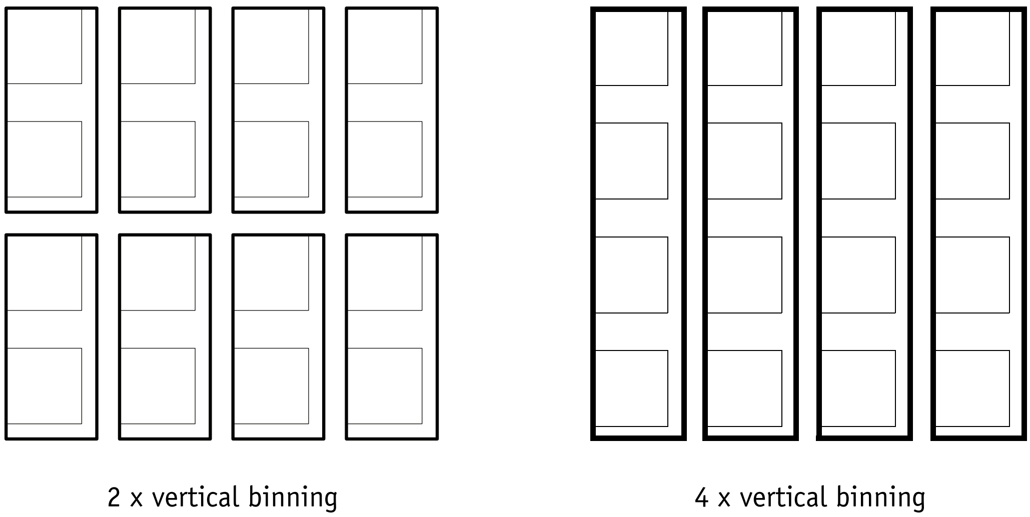


Figure 70: 2 x vertical binning and 4 x vertical binning

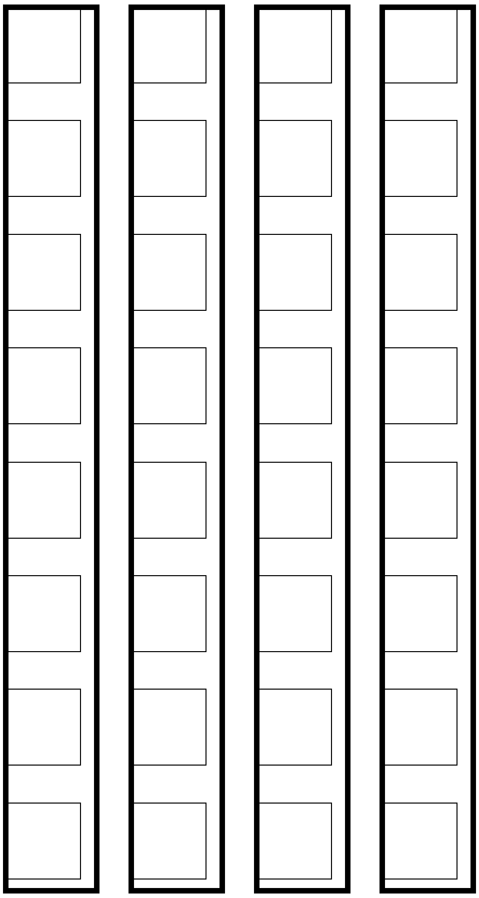


Figure 71: 8 x vertical binning

Note

Vertical resolution is reduced, but **signal-to noise ratio** (SNR) is increased by about 3, 6 or 9 dB (2 x, 4 x or 8 x binning).

Note

If **vertical binning** is activated the image may appear to be over-exposed and may require correction.

Note

The image appears **vertically** compressed in this mode and no longer exhibits a true aspect ratio.

Horizontal binning

In horizontal binning adjacent horizontal pixels in a line are combined digitally in the FPGA of the camera without accumulating the black level:

2 x horizontal binning: 2 pixel signals from 2 horizontal neighboring pixels are combined.

4 x horizontal binning: 4 pixel signals from 4 horizontal neighboring pixels are combined.

8 x horizontal binning: 8 pixel signals from 8 horizontal neighboring pixels are combined.

Light sensitivity

This means that in horizontal binning the **light sensitivity** of the camera is also increased by a factor of two (**6 dB**), 4 (**12 dB**) or 8 (**18 dB**). Signal-to-noise separation improves by approx. 3, 6 or 9 dB.

Horizontal resolution

Horizontal resolution is lowered, depending on the model.

Format_7 Mode_1

By default and without further remapping use **Format_7 Mode_1** for 2 x horizontal binning.

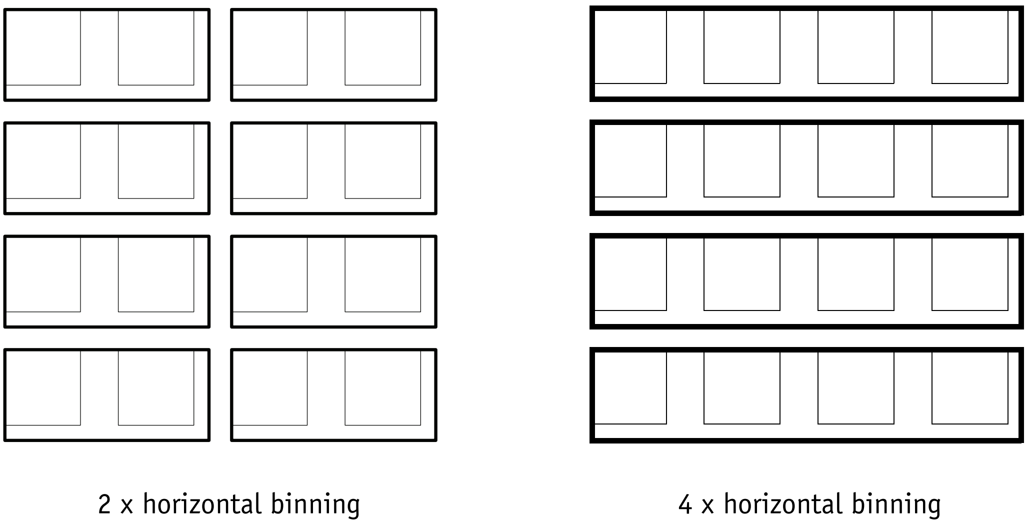
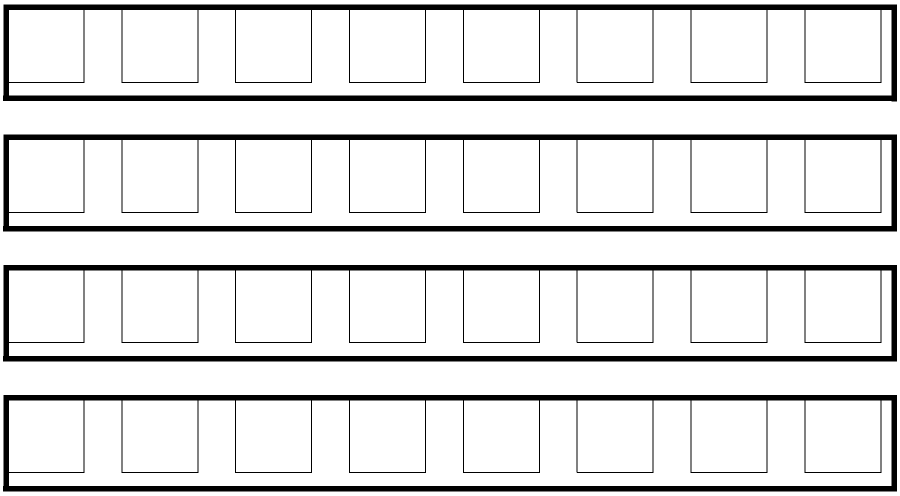


Figure 72: 2 x horizontal binning and 4 x horizontal binning



8 x horizontal binning

Figure 73: 8 x horizontal binning

Note

The image appears **horizontally** compressed in this mode and does no longer show true aspect ratio.

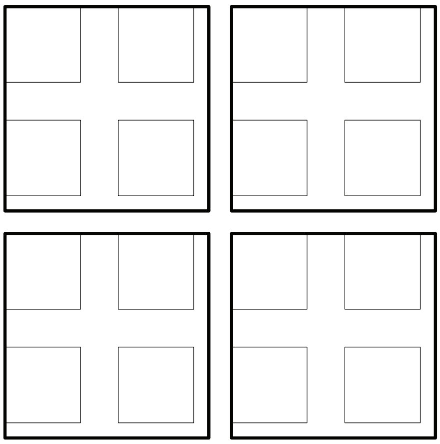
If **horizontal binning** is activated the image may appear to be over-exposed and must eventually be corrected.

2 x full binning/4 x full binning/8 x full binning

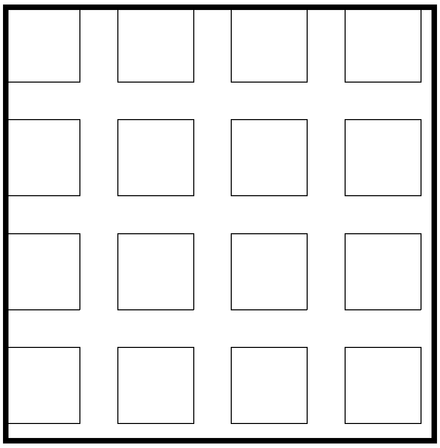
If horizontal and vertical binning are combined, every 4 (16 or 64) pixels are consolidated into a single pixel. At first two (4 or 8) horizontal pixels are put together and then combined vertically.

This increases light sensitivity by a total of a factor of 4 (16 or 64) and at the same time signal-to-noise separation is improved by about 6 (12 or 18) dB. Resolution is reduced, depending on the model.

By default and without further remapping use **Format_7 Mode_3** for 2 x full binning.



2 x full binning



4 x full binning

Figure 74: 2 x and 4 x full binning

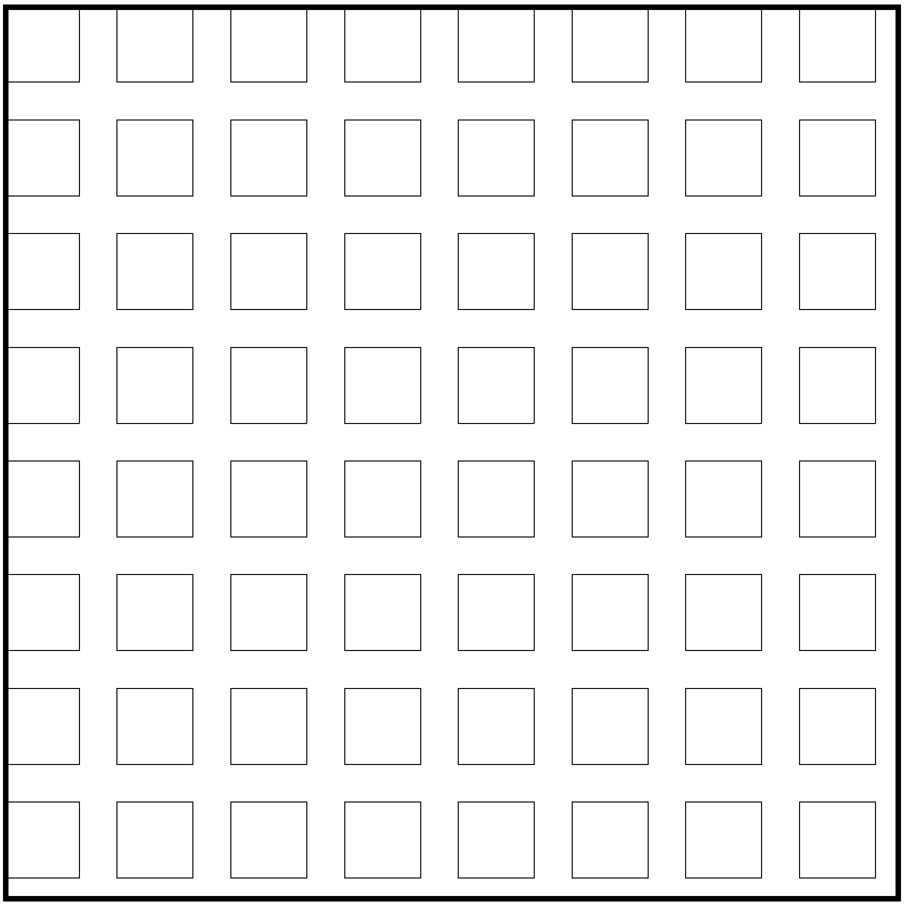


Figure 75: 8 x full binning

Sub-sampling (PIKE b/w and color)

What is sub-sampling?

Definition Sub-sampling is the process of skipping neighboring pixels (with the same color) while being read out from the CCD chip.

Which PIKE models have sub-sampling?

All PIKE models, both color and b/w, have this feature.

Description of sub-sampling

Sub-sampling is used primarily for the following reason:

- A reduction in the number of pixels and thus the amount of data while retaining the original image area angle and image brightness

Similar to binning mode the cameras support horizontal, vertical and h+v sub-sampling mode.

Format_7 Mode_4 By default and without further remapping use **Format_7 Mode_4** for

- b/w cameras: 2 out of 4 horizontal sub-sampling
- color cameras: 2 out of 4 horizontal sub-sampling

The different sub-sampling patterns are shown below.

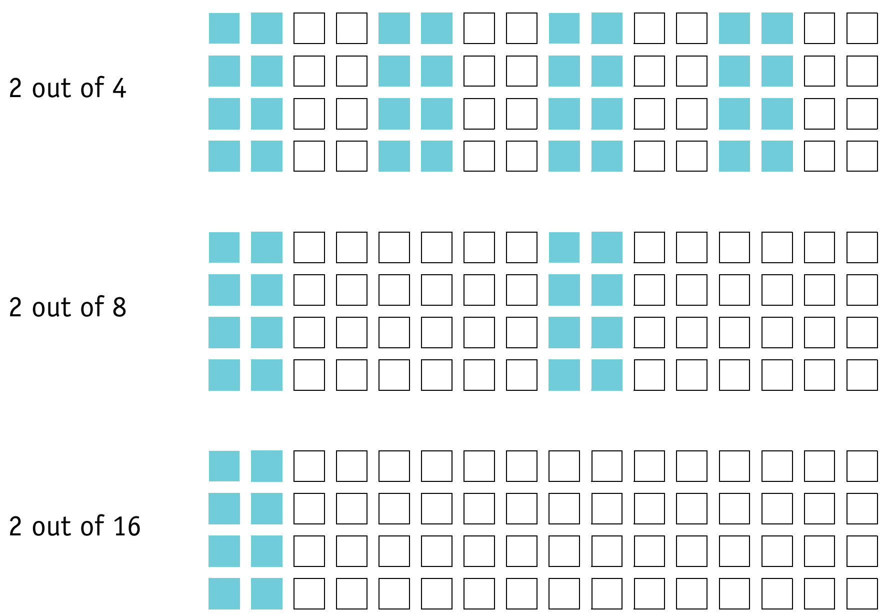


Figure 76: Horizontal sub-sampling (**b/w**)

2 out of 4

2 out of 8

2 out of 16

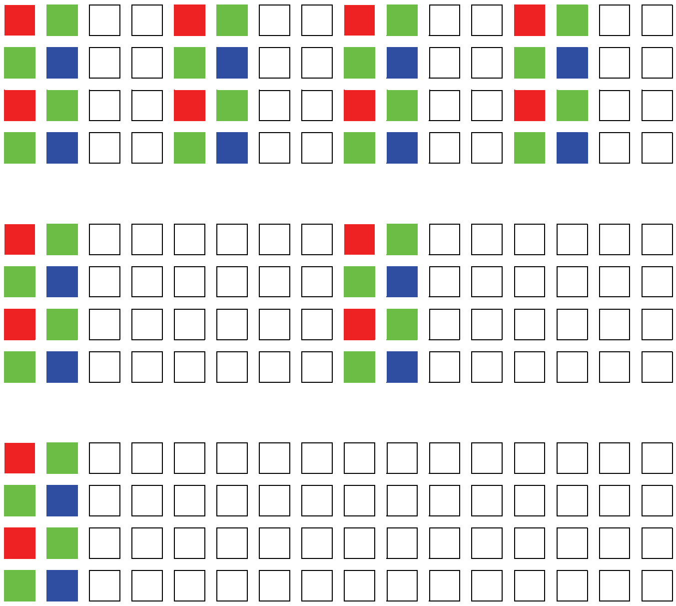


Figure 77: Horizontal sub-sampling (**color**)

Note

The image appears **horizontally compressed** in this mode and no longer exhibits a true aspect ratio.

Format_7 Mode_5 By default and without further remapping use **Format_7 Mode_5** for

- **b/w** cameras: 2 out of 4 vertical sub-sampling
- **color** cameras: 2 out of 4 vertical sub-sampling

The different sub-sampling patterns are shown below.

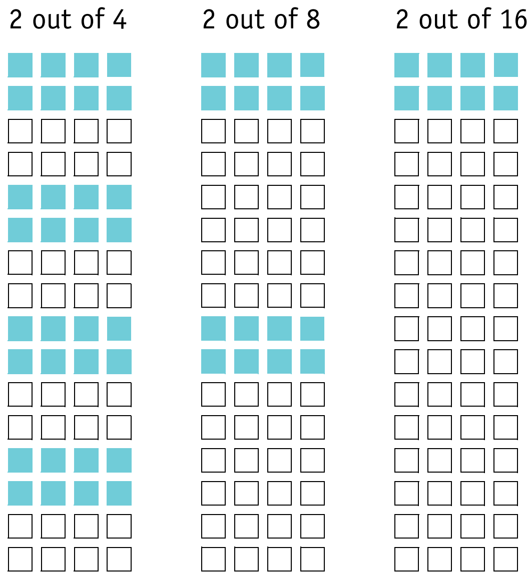


Figure 78: Vertical sub-sampling (**b/w**)

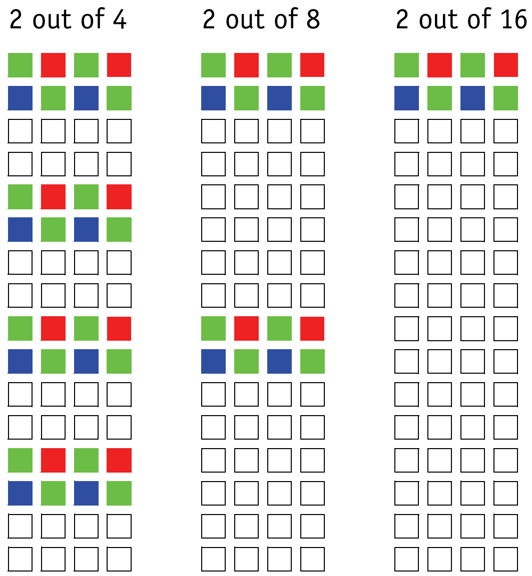


Figure 79: Vertical sub-sampling (**color**)

Note

The image appears vertically compressed in this mode and no longer exhibits a true aspect ratio.

Format_7 Mode_6

By default and without further remapping use **Format_7 Mode_6** for 2 out of 4 H+V sub-sampling

The different sub-sampling patterns are shown below.

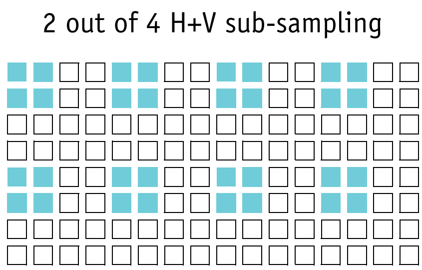


Figure 80: 2 out of 4 H+V sub-sampling (**b/w**)

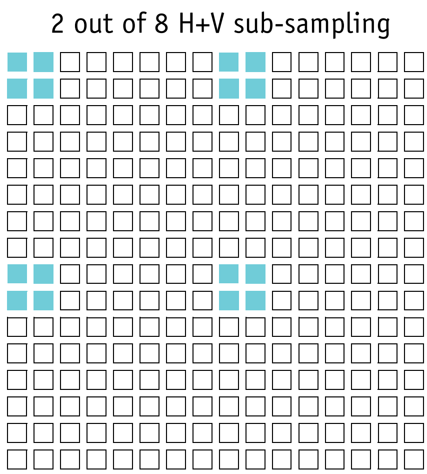


Figure 81: 2 out of 8 H+V sub-sampling (**b/w**)

2 out of 16 H+V sub-sampling

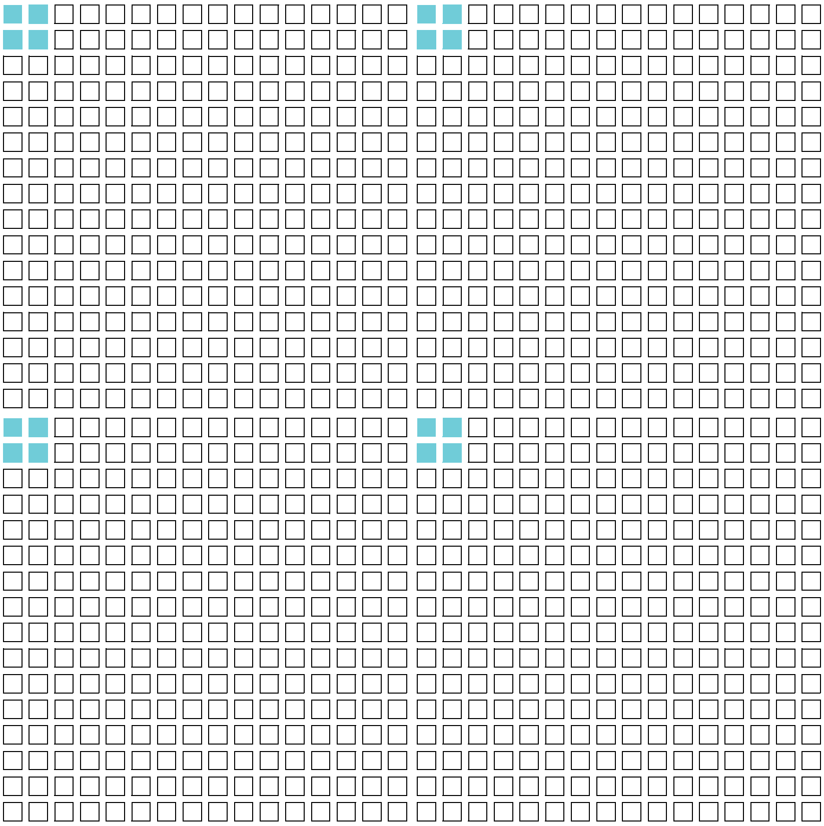


Figure 82: 2 out of 16 H+V sub-sampling (**b/w**)

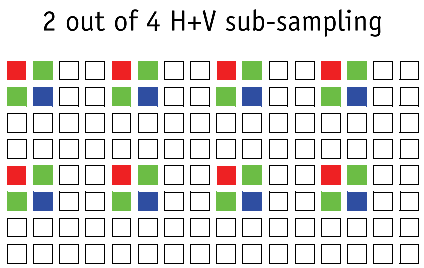


Figure 83: 2 out of 4 H+V sub-sampling (**color**)

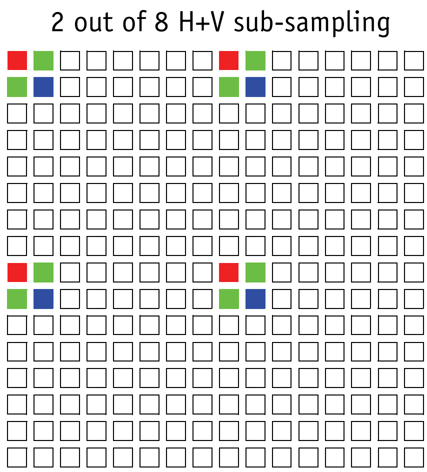


Figure 84: 2 out of 8 H+V sub-sampling (**color**)

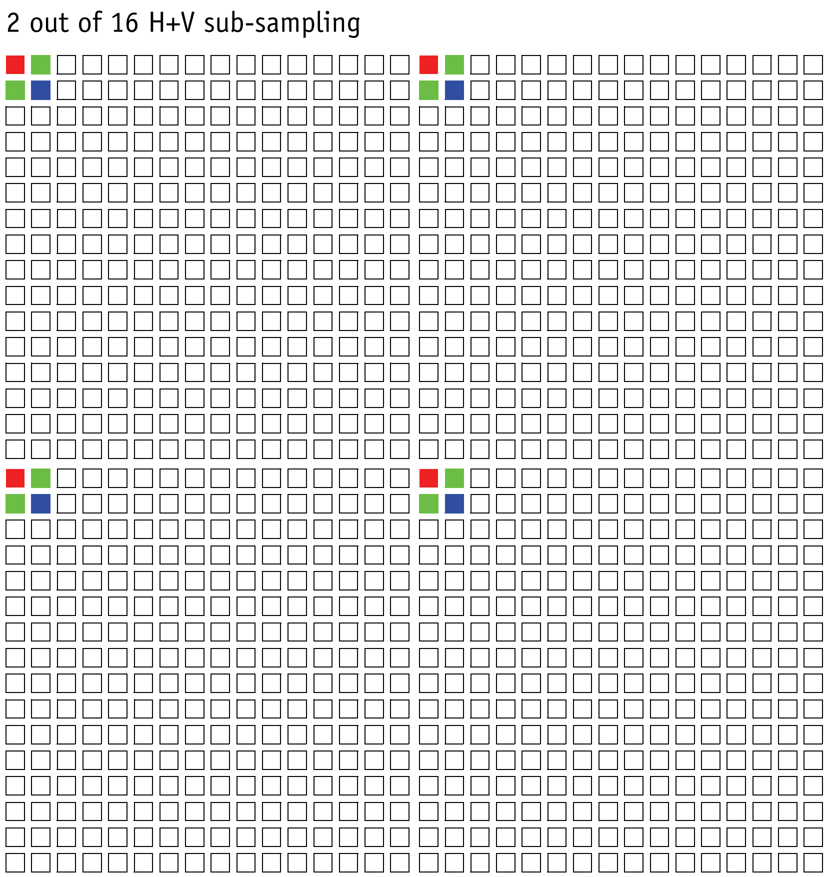


Figure 85: 2 out of 16 H+V sub-sampling (**color**)

Note

Changing sub-sampling modes involves the generation of new shading reference images due to a change in the image size.

Binning and sub-sampling access

The binning and sub-sampling modes described in the last two chapters are only available as pure binning or pure sub-sampling modes. A combination of both is not possible.

As you can see there is a vast amount of possible combinations. But the number of available Format_7 modes is limited and lower than the possible combinations.

Thus access to the binning and sub-sampling modes is implemented in the following way:

- **Format_7 Mode_0** is fixed and can not be changed
- A maximum of 7 individual AVT modes can be mapped to **Format_7 Mode_1** to **Mode_7**
(see Figure 86: Mapping of possible Format_7 modes to F7M1...F7M7 on page 150)
- Mappings can be stored via register (see Chapter Format_7 mode mapping on page 310) and are uploaded automatically into the camera on camera reset.
- The **default settings** (per factory) in the Format_7 modes are listed in the following table

Format_7	PIKE monochrome cameras Format_7	PIKE color cameras Format_7
Mode_0	full resolution, no binning, no sub-sampling	full resolution, no sub-sampling
Mode_1	2 x **horizontal** binning	--
Mode_2	2 x **vertical** binning	--
Mode_3	2 x **full** binning	--
Mode_4	2 out of 4 **horizontal** sub-sampling	2 out of 4 **horizontal** sub-sampling
Mode_5	2 out of 4 **vertical** sub-sampling	2 out of 4 **vertical** sub-sampling
Mode_6	2 out of 4 **full** sub-sampling	2 out of 4 **full** sub-sampling

Table 53: Default Format_7 binning and subsampling modes (per factory)

Note

- A **combination** of binning and sub-sampling modes is **not possible**. Use either pure binning or pure sub-sampling modes.
- The Format_ID numbers 0...31 in the binning/sub-sampling list do **not** correspond to any of the Format_7 modes.

F7 modes according to IIDC 1394

- F7M0 (no change)
- F7M1
- F7M2
- F7M3
- F7M4
- F7M5
- F7M6
- F7M7

mapping of each of 32 modes to F7M1..F7M7 possible

Format_ID (see p310)		**AVT modes**	
0	0 x horizontal	0 x vertical	binning (only b/w cameras)
1	2 x horizontal		
2	4 x horizontal		
3	8 x horizontal		
4	0 x horizontal	2 x vertical	
5	2 x horizontal		
6	4 x horizontal		
7	8 x horizontal		
8	0 x horizontal	4 x vertical	
9	2 x horizontal		
10	4 x horizontal		
11	8 x horizontal		
12	0 x horizontal	8 x vertical	
13	2 x horizontal		
14	4 x horizontal		
15	8 x horizontal		
16	2 out of 2 horizontal	2 out of 2 vertical	sub-sampling (color and b/w)
17	2 out of 4 horizontal		
18	2 out of 8 horizontal		
19	2 out of 16 horizontal		
20	2 out of 2 horizontal	2 out of 4 vertical	
21	2 out of 4 horizontal		
22	2 out of 8 horizontal		
23	2 out of 16 horizontal		
24	2 out of 2 horizontal	2 out of 8 vertical	
25	2 out of 4 horizontal		
26	2 out of 8 horizontal		
27	2 out of 16 horizontal		
28	2 out of 2 horizontal	2 out of 16 vertical	
29	2 out of 4 horizontal		
30	2 out of 8 horizontal		
31	2 out of 16 horizontal		

Figure 86: Mapping of possible Format_7 modes to F7M1...F7M7

Quick parameter change timing modes

Why new timing modes?

Former timing of the PIKE cameras showed the same behavior as MARLIN cameras:

- Frame rate or transfer rate is always constant (precondition: shutter < transfer time)
- The delay from shutter update until the change takes place: up to 3 frames. Figure 87: Former standard timing on page 151 demonstrates this behavior. It shows that the camera receives a shutter update command while the sensor is currently integrating (Sync is low) with shutter setting 400. The camera continues to integrate and this image is output with the next FVal. The shutter change command becomes effective with the next falling edge of sync and finally the image taken with shutter 200 is output with a considerable delay.
- Parameters that are sent to the camera faster than the max. frame rate per second are stored in a FIFO and are activated in consecutive images.

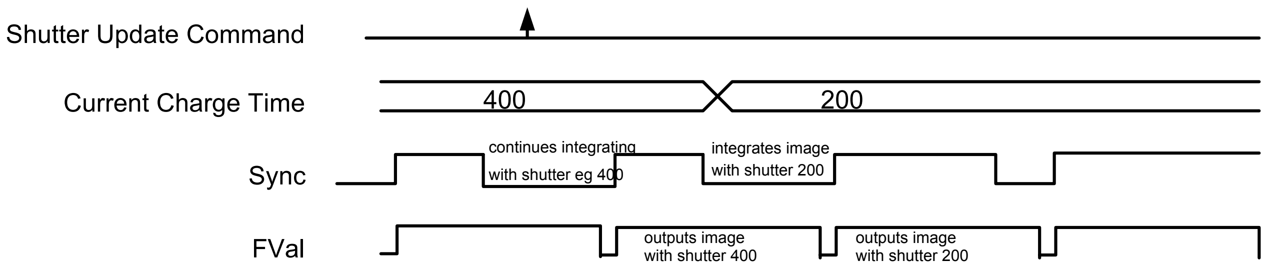


Figure 87: Former standard timing

Principally a PIKE camera is not able to recognize how many parameter the user will change. Due to the fact that communication between host and camera is asynchronous, it may happen that one part of parameter changes is done in image n+1 and the other part is done in image n+2.

To optimize the transfer of parameter changes there is a new timing mode called **Quick Format Change Mode**, which effectively resets the current shutter.

Therefore you can choose between the following update timing modes:

- **Standard Parameter Update Timing** (slightly modified from previous PIKE cameras)
- New: **Quick Format Change Mode**

In the following you find a short description of both timing modes:

Standard Parameter Update Timing

The **Standard Parameter Update Timing** keeps the frame rate constant and does not create any gaps between two image transfers via bus (precondition: exposure (shutter) time must be smaller than transfer time).

- Frame rate / transfer rate is always constant (if shutter time < transfer time)
- Delay from shutter update until change takes place is always 2 frames (delay from update command reception by FPGA and not by microcontroller)
- Parameters sent to the camera faster than max. frame rate are no longer stored in a FIFO. The last sent parameter will be activated for the next image. All others will be dropped. This ensures that the last image is shot with the last shutter setting.

New: Quick Format Change Mode (QFCM)

The **Quick Format Change Mode** creates gaps between two images. Current exposure is interrupted and the new exposure is started immediately with new parameters if during exposure (integration/shutter) an new shutter command is received.

- Frame rate / transfer rate can be *interrupted*. This is shown in the diagram below whenever FVal goes low after a reception of a new shutter command while Sync was low.
- Shutter will be interrupted, if the update command is received while camera integrates
- Delay from shutter update until change takes place is always 1 frame (the delay is calculated from update command reception by FPGA and not by microcontroller)

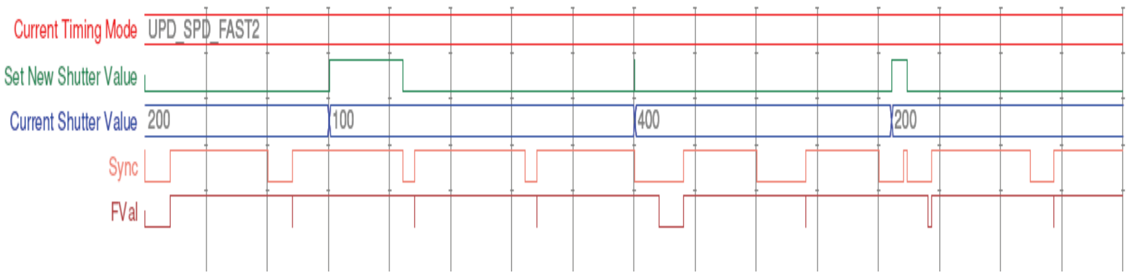


Figure 88: **Quick Format Change Mode**

How to transfer parameters to the camera

The following 3 variants of transferring the parameters are available with the firmware 3.x:

Transfer mode	Advantage ☺	Disadvantage ☹
Encapsulated Update (begin/ end)	☺ easy to use (standard quad writes in camera register is possible)	☹ one write access per register access
Parameter-List Update	☺ only one write access for all parameters ☺ fastest host→camera transfer (from 5 parameters on faster than encapsulated mode) ☺ handling of parameter list easy	☹ not so easy to use (block writes) ☹ max. 64 entries for parameter list
Standard Update (IIDC)	☺ compliant with IIDC V1.31	☹ non deterministic change of parameters

Table 54: Comparison of 3 transfer modes

In the following you find a short description of each variant:

Encapsulated Update (begin/end)

The **Encapsulated Update (begin/end)** has the following characteristics:

- Host will set a parameter update begin flag in the camera
- Host will send several parameters to the camera and then signalize end by resetting the flag
- All parameters will become active for the same next image
- Dependent on timing mode, the camera
  - (standard Update): uses the previous parameters until the update flag is reset
  - (**Quick Format Change Mode**): waits until the update flag is reset.

In the **Encapsulated Update (begin/end)** the exact sequence is:

1. Parameter update begin (advanced feature register)
2. Standard IIDC register update (1..N register) (standard feature register)
3. Parameter update end (advanced feature register)

Camera timing behavior is like this:

Fast Parameter Update Timing	Quick Format Change Mode
After the parameter update stop command all changed parameters are valid for the available next image. Frame rate is constant.	After the parameter update start command a current transfer is interrupted. A started exposure will be interrupted until the next parameter update stop command. Exposure of the next image with new parameters is started. There may be a gap between two succeeding images but images are always transmitted compeletely.

Table 55: **Encapsulated Update (begin/end)**: comparison of standard timing and fast timing 2

If after end of time-out (10 seconds after **Quick Format Change Mode**) no **parameter update end** is sent, all changes will become valid.

A new write event of **parameter update begin** starts time-out again.

Parameter-List Update

In the **Parameter-List Update** mode a complete list with IIDC addresses and values of up to 64 parameters is sent to the camera.

- Host sends a list with parameters to the camera (advanced feature space)
- Microcontroller processes that list
- All parameters will become active for the same image
- Dependent on timing mode, the camera will:
  - **Standard Format Change Mode:** use the previous parameters until the new parameter set is copied to the FPGA
  - **Quick Format Change Mode (QFCM)**: waits until all parameters have been copied to the FPGA and may interrupt an already started integration for a new integration with the new settings

Example of parameter list:

Address	Value
0xF0F0081C	0x80000100
0xF0F00820	0x800000ac
0xF0F00818	0x82000001
...	...

Table 56: Example of parameter list

The exact sequence is:

Block-write (this needs to be a functionality of the underlying software stack (e.g. AVT FirePackage). It may not be available for third party IIDC software stacks.) of list to advanced feature address

Camera timing behavior is like this:

Fast Parameter Update Timing	Quick Format Change Mode (QFCM)
After block write command is processed in the camera all changed parameters are valid for the available next image. Frame rate is constant.	After transfer of the parameter list via block write a current transfer will be finished. A started exposure will be interrupted until the microcontroller has processed the list and copied it into the FPGA. Exposure of the next image with new parameters is started. There may be a gap between two images.

Table 57: **Parameter-List Update**: comparison of standard timing and **QFCM**

Standard Update (IIDC)

In the **Standard Update (IIDC)** mode single parameter are sent to the camera.

- **Standard Update (IIDC)**shows same behavior as MARLIN
- Parameter will be sent from host to camera and will be activated as soon as possible without interruption of the transfer
- If the host updates more than one parameter (without block write) the parameters may become active in different images
- **Standard Update (IIDC)** can be combined with the new parameter update timing modes

Camera timing behavior is like this:

Fast Parameter Update Timing	Quick Format Change Mode (QFCM)
After sending a new parameter value, the changed parameter value is valid for the available next image. Frame rate is constant.	After sending a new parameter value, the changed parameter value is valid for the available next image. A running exposure will be interrupted and the image is dropped. There may be a gap between two consecutive image transfers.

Table 58: **Standard Update (IIDC)**: comparison of **Standard Format Change Mode** and **QFCM**

Packed 12-Bit Mode

All PIKE cameras have the so-called **Packed 12-Bit Mode**. This means: two 12-bit pixel values are packed into 3 bytes instead of 4 bytes.

B/w cameras	Color cameras
Packed 12-Bit MONO camera mode SmartView: MONO12	**Packed 12-Bit RAW** camera mode SmartView: RAW12
Mono and raw mode have the same implementation.	

Table 59: **Packed 12-Bit Mode**

Note

For data block packet format see Table 43: Packed 12-Bit Mode (mono and raw) Y12 format on page 108.

For data structure see Table 44: Data structure of Packed 12-Bit Mode (mono and raw) on page 109.

The color codings are implemented via Vendor Unique Color_Coding according to IIDC V1.31: COLOR_CODING_INQ @ 024h...033h, IDs=128-255)

See Table 132: Format_7 control and status register on page 276.

Mode	Color_Coding	ID
Packed 12-Bit MONO	ECCID_MONO12	ID=132
Packed 12-Bit RAW	ECCID_RAW12	ID=136

Table 60: **Packed 12-Bit Mode**: color coding

High SNR mode (High Signal Noise Ratio)

To configure this feature in an advanced register: See Table 157: High Signal Noise Ratio (HSNR) on page 306.

In this mode the camera grabs and averages a set number of images and outputs one image with the same bit depth and the same brightness. This means that the camera will output an 8-bit averaged image when an 8-bit image format is selected.

Because of the fact that normally uncorrelated (photon-, amplifier-) noise dominates over correlated noise (fixed pattern noise), adding two images will double (6 dB) the gray levels but only increase the noise levels by $\sqrt{2}$ (3 dB).

This enhances both the dynamic range as well as the signal-to-noise ratio.

Consequently adding 256 8-bit images will lead to a potential signal-to-noise enhancement of 24 dB or a resulting bit depth of 16 bit.

Note

- The averaged image is output at a lower frame rate being exactly the fraction: frame rate/number of images.
- The camera must be in idle before turning this feature on.
- The potential SNR enhancement may be lower when using more than 8-bit original bit depth.
- Select 16-bit image format in order to take advantage of the full potential SNR and DNR (**Dy**Namic **R**ange) enhancements.

Frame memory and deferred image transport

An image is normally captured and transported in consecutive steps. The image is taken, read out from the sensor, digitized and sent over the 1394 bus.

Deferred image transport

As all PIKE cameras are equipped with built-in image memory, this order of events can be paused or delayed by using the **deferred image transport** feature.

PIKE cameras are equipped with 64 MB of RAM. The table below shows how many frames can be stored by each model. The memory operates according to the FIFO (first in, first out) principle. This makes addressing for individual images unnecessary.

Model	Memory size
PIKE F-032B/C PIKE F-032B/C fiber	105 frames
PIKE F-100B/C PIKE F-100B/C fiber	32 frames
PIKE F-145B/C PIKE F-145B/C fiber	22 frames
PIKE F-145B/C-15fps PIKE F-145B/C fiber-15fps	22 frames
PIKE F-210B/C PIKE F-210B/C fiber	15 frames
PIKE F-421B/C PIKE F-421B/C fiber	6 frames
PIKE F-505B/C PIKE F-505B/C fiber	5 frames

Table 61: FIFO memory size

Deferred image transport is especially useful for multi-camera applications:

Assuming several cameras acquire images concurrently. These are stored in the built-in image memory of every camera. Until this memory is full, the limiting factor of available bus bandwidth, DMA- or ISO-channel is overcome.

Image transfer is controlled from the host computer by addressing individual cameras one after the other and reading out the desired number of images.

Note

To configure this feature in an advanced register: See Table 146: Deferred image configuration register on page 296.

HoldImg mode

By setting the **HoldImg** flag, transport of the image over the 1394 bus is stopped completely. All captured images are stored in the internal **ImageFiFo**. The camera reports the maximum possible number of images in the **FiFoSize** variable.

Note

- Pay attention to the maximum number of images that can be stored in **FiFo**. If you capture more images than the number in **FiFoSize**, the oldest images are overwritten.
- The extra **SendImage** flag is set to **true** to import the images from the camera. The camera sends the number of images set in the **NumOfImages** parameter.
- If **NumOfImages** is **0,** all images stored in FIFO will be sent.
- If **NumOfImages** is not **0**, the corresponding number of images will be sent.
- If the **HoldImg** field is set to **false**, all images in **ImageFIFO** will be deleted. No images will be sent.
- The last image in the FiFo will be corrupted, when simultaneously used as input buffer while being read out. In this case read out one image less than max. buffer size.
- **NumOfImages** is incremented after an image was read out of the sensor and therefore stored into the onboard image FIFO.
- **NumOfImages** is decremented after the last isochronous packet of an image was handed over to the IEEE1394 chipset of the camera.

The following screenshot shows the sequence of commands needed to work with deferred mode.

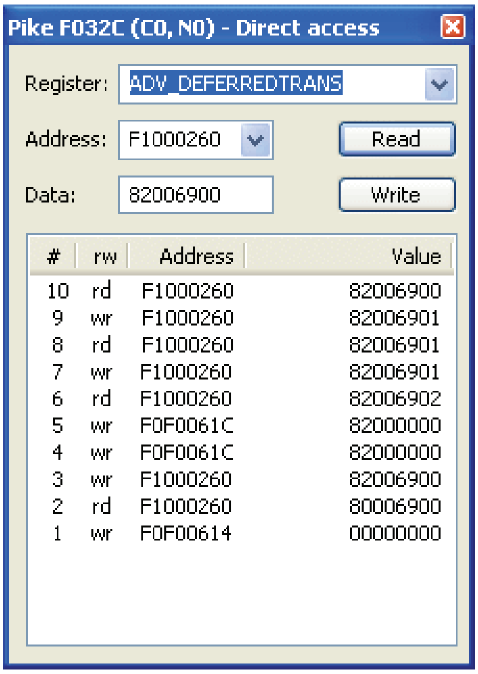


Figure 89: Example: Controlling deferred mode (SmartView - Direct Access; PIKE F-032C)

For a description of the commands see the following table:

#	rw	Address	Value	Description
10	rd	F1000260	82006900h	Check how many images are left in FiFo
9	wr	F1000260	86006901h	Read out the second image of FiFo
8	rd	F1000260	82006901h	Check how many images are left in FiFo
7	wr	F1000260	86006901h	Read out the first image of FiFo
6	rd	F1000260	82006902h	Check that two images are in FiFo
5	wr	F0F0061C	82000000h	Do second one-shot
4	wr	F0F0061C	82000000h	Do first one-shot
3	wr	F1000260	82006900h	Switch deferred mode on
2	rd	F1000260	80006900h	Check pres. of deferred mode and FiFo size (69h → 105 frames)
1	wr	F0F00614	00000000h	Stop continuous mode of camera

Table 62: Example: Controlling deferred mode (SmartView - Direct Access; PIKE F-032C)

FastCapture mode

Note

This mode can be activated only in Format_7.

By setting **FastCapture** to **false**, the maximum frame rate both for image acquisition and read out is associated with the packet size set in the BYTE_PER_PACKET register. The lower this value is, the lower the attainable frame rate is.

By setting **FastCapture** to **true**, all images are recorded at the highest possible frame rate, i.e. the setting above does not affect the frame rate for the image intake but only the read out. The speed of the image transport over the 1394 bus can be defined via the **BytesPerPacket** register. This mode is ideal for applications where a burst of images need to be recorded at the highest sensor speed but the output can be at a lower frame frequency to save bandwidth.

Similar to the HoldImg mode, captured images will be stored in the internal image FIFO, if the transport over the 1394 bus is slower than images are captured.

Color interpolation (BAYER demosaicing)

The color sensors capture the color information via so called primary color (R-G-B) filters placed over the individual pixels in a **BAYER mosaic** layout. An effective BAYER → RGB color interpolation already takes place in all PIKE color version cameras.

In color interpolation a red, green or blue value is determined for each pixel. An AVT proprietary BAYER demosaicing algorithm is used for this interpolation (max. 3x3), optimized for both sharpness of contours as well as reduction of false edge coloring.

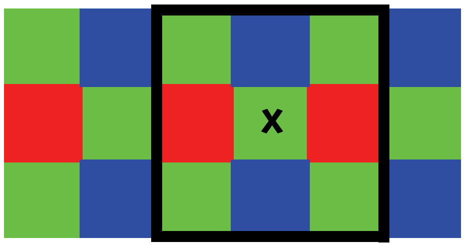


Figure 90: Bayer demosaicing (example of 3x3 matrix)

Color processing can be bypassed by using so-called RAW image transfer.

RAW-mode is primarily used to

- save bandwidths on the IEEE 1394 bus
- achieve higher frame rates
- use different BAYER demosaicing algorithms on the PC (for Pike F-145 the first pixel of the sensor is RED, for all other Pikes the first pixel is GREEN followed by RED).

Note

If the PC does not perform BAYER to RGB post-processing, the b/w image will be superimposed with a checkerboard pattern.

Sharpness

The PIKE color models are equipped with a two step sharpness control, applying a discreet horizontal high pass in the Y channel as shown in the next three line profiles.

Sharpness 0, 1 and 2 is calculated with the following scheme:

Sharpness value			
0	0	1	0
1	-0.25	+1.5	-0.25
2	-0.5	2	-0.5

Table 63: Sharpness scheme

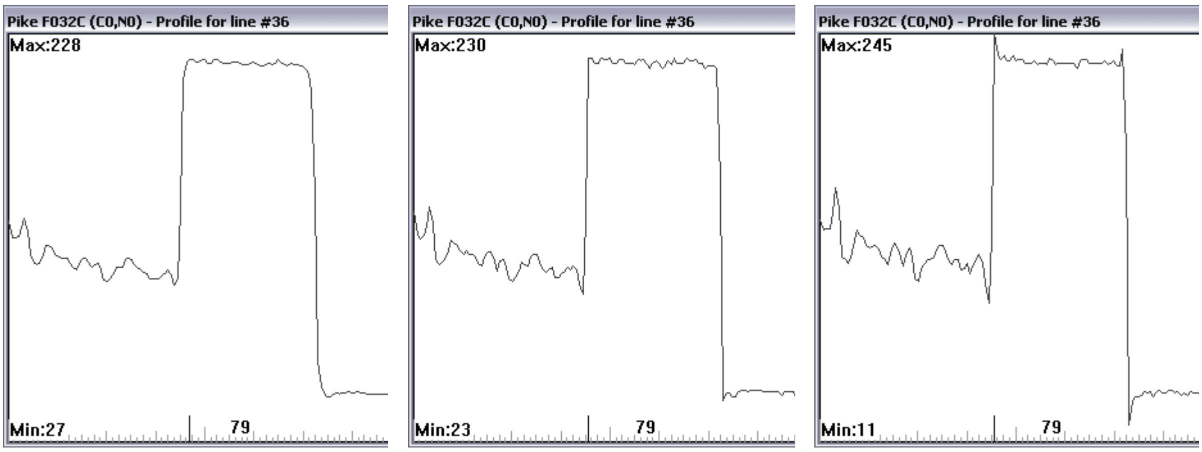


Figure 91: Sharpness: left: 0, middle: 1, right: 2

Note

Sharpness does not show any effect on PIKE color models in the Raw8 and Raw16 format, because color processing is put off in all Raw formats.

To configure this feature in feature control register: See Table 130: Feature control register on page 272.

Hue and saturation

PIKE CCD color models are equipped with hue and saturation registers.

The hue register at offset 810h allows the color of objects to be changed without altering the white balance, by +/- 40 steps (+/- 10°) from the nominal perception. Use this setting to manipulate the color appearance after having carried out the white balance.

The saturation register at offset 814h allows the intensity of the colors to be changed between 0 and 200% in steps of 1/256.

This means a setting of zero changes the image to black and white and a setting of 511 doubles the color intensity compared to the nominal one at 256.

To configure this feature in feature control register: See Table 130: Feature control register on page 272.

Note

Hue and saturation do not show any effect on PIKE color models in the Raw8 and Raw16 format, because color processing is switched off in all Raw formats.

Color correction

Why color correction?

The spectral response of a CCD is different of those of an output device or the human eye. This is the reason for the fact that perfect color reproduction is not possible. In each PIKE camera there is a factory setting for the color correction coefficients, see Chapter GretagMacbeth ColorChecker on page 165.

Color correction is needed to eliminate the overlap in the color channels. This overlap is caused by the fact that:

- Blue light: is seen by the red and green pixels on the CCD
- Red light: is seen by the blue and green pixels on the CCD
- Green light: is seen by the red and blue pixels on the CCD

The color correction matrix subtracts out this overlap.

Color correction in AVT cameras

In AVT cameras the color correction is realized as an additional step in the process from the sensor data to color output.

Color correction is used to harmonize colors for the human eye. With other AVT (color) cameras so far, you had the opportunity to use it or to switch it off.

PIKE cameras introduce for the first time the so-called color correction matrix. This means: you are now able to manipulate the color-correction coefficients yourself.

Color correction: formula

Before converting to the YUV format, color correction on all color models is carried out after BAYER demosaicing via a matrix as follows:

$$\begin{aligned} \text{red}^* &= \text{Crr} \times \text{red} + \text{Cgr} \times \text{green} + \text{Cbr} \times \text{blue} \\ \text{green}^* &= \text{Crg} \times \text{red} + \text{Cgg} \times \text{green} + \text{Cbg} \times \text{blue} \\ \text{blue}^* &= \text{Crb} \times \text{red} + \text{Cgb} \times \text{green} + \text{Cbb} \times \text{blue} \end{aligned}$$

Formula 1: Color correction

GretagMacbeth ColorChecker

Sensor-specific coefficients C_{xy} are scientifically generated to ensure that GretagMacbeth™ ColorChecker®-colors are displayed with highest color fidelity and color balance.

These coefficients are stored in user set 0 and can not be overwritten (factory setting).

Changing color correction coefficients

You can change the color-correction coefficients according to your own needs. Changes are stored in the user settings.

Note

If you need technical assistance, call the AVT support.

Note

- A number of 1000 equals a color correction coefficient of 1.
- To obtain an identity matrix set values of 1000 for the diagonal elements an 0 for all others. As a result you get colors like in the RAW modes.
- The sums of all rows should be equal to each other. If not, you get tinted images.
- Color correction values range -1000..+2000 and are signed 32 bit.
- In order for white balance to work properly ensure that the row sum equals 1000.
- Each row should sum up to 1000. If not, images are less or more colorful.
- The maximum row sum is limited to 2000.

To configure the color correction coefficients in an advanced register: See Table 152: Color correction on page 303.

To change the color-correction coefficients in **SmartView**, go to **Adv3** tab.

Switch color correction on/off

Color correction can also be switched off in YUV mode:

To configure this feature in an advanced register: See Table 152: Color correction on page 303.

Note

Color correction is deactivated in RAW mode.

Color conversion (RGB → YUV)

The conversion from RGB to YUV is made using the following formulae:

$$
\begin{aligned}
Y &= \quad 0.3 \times R + 0.59 \times G + \ 0.11 \times B \\
U &= -0.169 \times R - 0.33 \times G + 0.498 \times B + 128 \text{ (@ 8 bit)} \\
V &= 0.498 \times R - 0.420 \times G - 0.082 \times B + 128 \text{ (@ 8 bit)}
\end{aligned}
$$

Formula 2: RGB to YUV conversion

Note

- As mentioned above: Color processing can be bypassed by using so-called RAW image transfer.
- RGB → YUV conversion can be bypassed by using RGB8 format and mode. This is advantageous for edge color definition but needs more bandwidth (300% instead of 200% relative to b/w or RAW consumption) for the transmission, so that the maximal frame frequency will drop.

Bulk Trigger

See Chapter Trigger modi on page 173 and the following pages.

Level Trigger

See Trigger Mode 1 in Chapter Trigger modi on page 173.

Serial interface

All PIKE cameras are equipped with the SIO (serial input/output) feature as described in IIDC V1.31. This means that the PIKE’s serial interface can be used as a general RS232 interface.

Data written to a specific address in the IEEE 1394 address range will be sent through the serial interface. Incoming data of the serial interface is put in a camera buffer and can be polled via simple read commands from this buffer. Controlling registers enable the settings of baud rates and the check of buffer sizes and serial interface errors.

Note

- Hardware handshaking is not supported.
- Typical PC hardware does not usually support 230400 bps or more.

Base address for the function is: F0F02100h.

To configure this feature in access control register (CSR):

Offset	Name	Field	Bit	Description
000h	SERIAL_MODE_REG	Baud_Rate	[0..7]	Baud rate setting WR: Set baud rate RD: Read baud rate 0: 300 bps 1: 600 bps 2: 1200 bps 3: 2400 bps 4: 4800 bps 5: 9600 bps 6: 19200 bps 7: 38400 bps 8: 57600 bps 9: 115200 bps 10: 230400 bps Other values reserved
		Char_Length	[8..15]	Character length setting WR: Set data length (7 or 8 bit) RD: Get data length 7: 7 bits 8: 8 bits Other values reserved
		Parity	[16..17]	Parity setting WR: Set parity RD: Get parity setting 0: None 1: Odd 2: Even
		Stop_Bit	[18..19]	Stop bits WR: Set stop bit RD: Get stop bit setting 0: 1 1: 1.5 2: 2
		-	[20..23]	Reserved
		Buffer_Size_Inq	[24..31]	Buffer Size (RD only) This field indicates the maximum size of receive/transmit data buffer. If this value=1, Buffer_Status_Control and SIO_Data_Register Char 1-3 should be ignored.

Table 64: Serial input/output control and status register (SIO CSR)

Offset	Name	Field	Bit	Description
0004h	SERIAL_CONTROL_REG	RE	[0]	Receive enable RD: Current status WR: 0: Disable 1: Enable
		TE	[1]	Transmit enable RD: Current status WR: 0: disable 1: Enable
		-	[2..7]	Reserved
	SERIAL_STATUS_REG	TDRD	[8]	Transmit data buffer ready Read only 0: not ready 1: ready
		-	[9]	Reserved
		RDRD	[10]	Receive data buffer ready Read only 0: not ready 1: ready
		-	[11]	Reserved
		ORER	[12]	Receive data buffer overrun error Read: current status WR: 0: no error (to clear status) 1: Ignored
		FER	[13]	Receive data framing error Read: current status WR: 0: no error (to clear status) 1: Ignored
		PER	[14]	Receive data parity error Read: current status WR: 0: no error (to clear status) 1: Ignored
		-	[15..31]	Reserved

Table 64: Serial input/output control and status register (SIO CSR)

Offset	Name	Field	Bit	Description
008h	RECEIVE_BUFFER_STATUS_CONTRL	RBUF_ST	[0..7]	SIO receive buffer status RD: Number of bytes pending in receive buffer WR: Ignored
		RBUF_CNT	[8..15]	SIO receive buffer control RD: Number of bytes to be read from the receive FiFo WR: Number of bytes left for readout from the receive FiFo
		-	[16..31]	Reserved
00Ch	TRANSMIT_BUFFER_STATUS_CONTRL	TBUF_ST	[0..7]	SIO output buffer status RD: Space left in TX buffer WR: Ignored
		TBUF_CNT	[8..15]	SIO output buffer control RD: Number of bytes written to transmit FiFo WR: Number of bytes to transmit
		-	[16..31]	Reserved
010h .. 0FFh		-		Reserved
100h	SIO_DATA_REGISTER	CHAR_0	[0..7]	Character_0 RD: Read character from receive buffer WR: Write character to transmit buffer
	SIO_DATA_REGISTER	CHAR_1	[8..15]	Character_1 RD: Read character from receive buffer+1 WR: Write character to transmit buffer+1
	SIO_DATA_REGISTER	CHAR_2	[16..23]	Character_2 RD: Read character from receive buffer+2 WR: Write character to transmit buffer+2
	SIO_DATA_REGISTER	CHAR_3	[24..31]	Character_3 RD: Read character from receive buffer+3 WR: Write character to transmit buffer+3
104h .. 1FFH	SIO_DATA_REGISTER_ALIAS		[0..31]	Alias SIO_Data_Register area for block transfer

Table 64: Serial input/output control and status register (SIO CSR)

To read data:

1. Query RDRD flag (buffer ready?) and write the number of bytes the host wants to read to RBUF_CNT.
2. Read the number of bytes pending in the receive buffer RBUF_ST (more data in the buffer than the host wanted to read?) and the number of bytes left for reading from the receive FiFo in RBUF_CNT (host wanted to read more data than were in the buffer?).
3. Read received characters from SIO_DATA_REGISTER, beginning at char 0.
4. To input more characters, repeat from step 1.

To write data:

1. Query TDRD flag (buffer ready?) and write the number of bytes to send (copied from SIO register to transmit FiFo) to TBUF_CNT.
2. Read the available data space left in TBUF_ST (if the buffer can hold more bytes than are to be transmitted) and number of bytes written to transmit buffer in TBUF_CNT (if more data is to be transmitted than fits in the buffer).
3. Write character to SIO_DATA_REGISTER, beginning at char 0.
4. To output more characters, repeat from step 1.

Note

- Contact your local dealer if you require further information or additional test programs or software.
- AVT recommends the use of Hyperterminal™ or other communication programs to test the functionality of this feature. Alternatively use SmartView to try out this feature.

Controlling image capture

The cameras support the SHUTTER_MODES specified in IIDC V1.31. For all models this shutter is a **global pipelined shutter**; meaning that all pixels are exposed to the light at the same moment and for the same time span.

Pipelined means that the shutter for a new image can already happen, while the preceding image is transmitted.

In continuous modes the shutter is opened shortly before the vertical reset happens, thus acting in a frame-synchronous way.

Combined with an external trigger, it becomes asynchronous in the sense that it occurs whenever the external trigger occurs. Individual images are recorded when an external trigger impulse is present. This ensures that even fast moving objects can be grabbed with no image lag and with minimal image blur.

The external trigger is fed as a TTL signal through Pin 4 of the camera I/O connector.

Trigger modi

The cameras support IIDC conforming Trigger_Mode_0 and Trigger_Mode_1 and special Trigger_Mode_15 (bulk trigger).

Trigger Mode	also known as	Description
Trigger_Mode_0	Edge mode	Sets the shutter time according to the value set in the shutter (or extended shutter) register
Trigger_Mode_1	Level mode	Sets the shutter time according to the active low time of the pulse applied (or active high time in the case of an inverting input)
Trigger_Mode_15	Programmable mode	Is a **bulk trigger**, combining one external trigger event with continuous or one-shot or multi-shot internal trigger

Table 65: Trigger modi

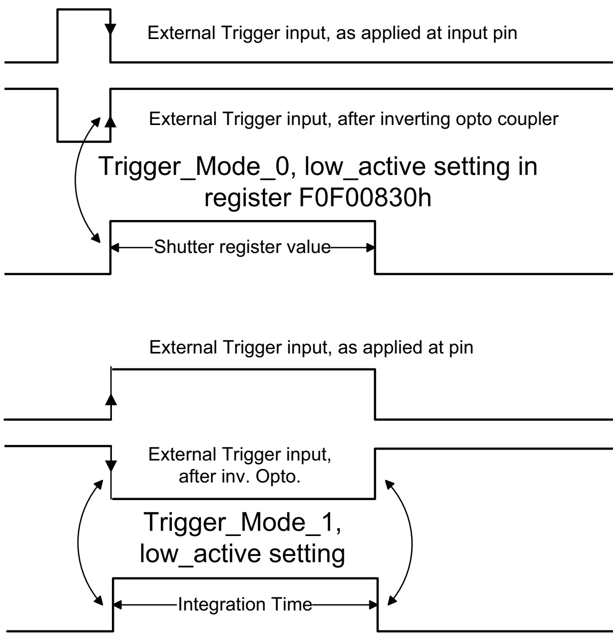


Figure 92: Trigger_mode_0 and 1

Bulk Trigger (Trigger_Mode_15)

Trigger_Mode_15 is an extension to the IIDC trigger modes. One external trigger event can be used to trigger a multitude of internal image intakes.

This is especially useful for:

- Grabbing exactly one image based on the first external trigger.
- Filling the camera's internal image buffer with one external trigger without overriding images.
- Grabbing an unlimited amount of images after one external trigger (surveillance)

The Figure below illustrates this mode.

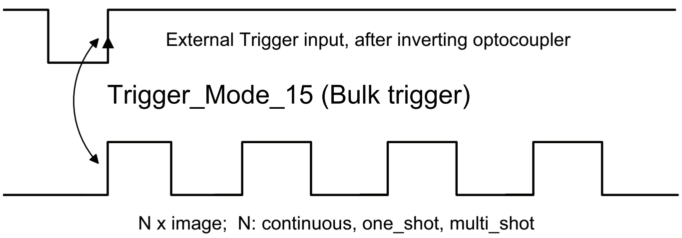


Figure 93: Trigger_Mode_15

The functionality is controlled via bit [6] and bitgroup [12-15] of the following register:

Register	Name	Field	Bit	Description
0xF0F00830	TRIGGER_MODE	Presence_Inq	[0]	Presence of this feature: 0: N/A 1: Available
		Abs_Control	[1]	Absolute value control 0: Control with value in the **Value** field 1: Control with value in the **Absolute** value CSR If this bit = 1 the value in the **Value** field has to be ignored
		-	[2..5]	Reserved
		ON_OFF	[6]	Write: ON or OFF this feature Read: read a status 0: OFF 1: ON In this bit = 0, other fields will be read only.
		Trigger_Polarity	[7]	Select trigger polarity (Except for software trigger) If Polarity_Inq is 1: Write to change polarity of the trigger input. Read to get polarity of the trigger input. If Polarity_Inq is 0: Read only. 0: Low active input 1: High active input
		Trigger_Source	[8..10]	Select trigger source Set trigger source ID from trigger source ID_Inq
		Trigger_Value	[11]	Trigger input raw signal value read only 0: Low 1: High
		Trigger_Mode	[12..15]	Trigger_Mode (Trigger_Mode_0..15)
		-	[16..19]	Reserved
		Parameter	[20..31]	Parameter for trigger function, if required (optional)

Table 66: Trigger_Mode_15 (Bulk Trigger)

The screenshots below illustrate the use of Trigger_Mode_15 on a register level:

- Line #1switches continuous mode off, leaving viewer in listen mode.
- Line #2 prepares 830h register for external trigger and Mode_15.

Left = continuous	Middle = one shot	Right = multi shot
Line #3 switches camera back to continuous mode. Only one image is grabbed precisely with the first external trigger. To repeat rewrite line three.	Line #3 toggles one-shot bit [0] of the one-shot register 61C so that only one image is grabbed, based on the first external trigger. To repeat rewrite line three.	Line #3 toggles multi-shot bit [1] of the one-shot register 61C so that Ah images are grabbed, starting with the first external trigger. To repeat rewrite line three.

Table 67: Description: using Trigger_Mode_15: continuous, one-shot, multi-shot

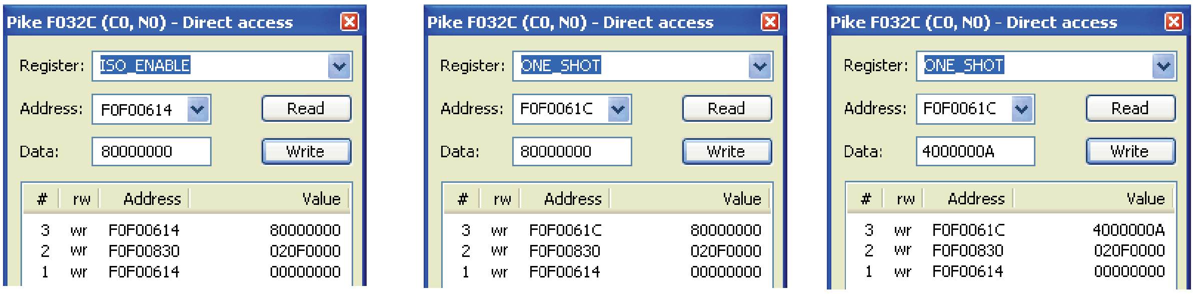


Figure 94: Using Trigger_Mode_15: continuous, one-shot, multi-shot

Note

Shutter for the images is controlled by shutter register.

Trigger delay

As already mentioned earlier the cameras feature various ways to delay image capture based on external trigger.

With IIDC V1.31 there is a standard CSR at Register F0F00534/834h to control a delay up to FFFh x time base value. The following table explains the Inquiry register and the meaning of the various bits.

Register	Name	Field	Bit	Description
0xF0F00534	TRIGGER_DLY_INQUIRY	Presence_Inq	[0]	Indicates presence of this feature (read only)
		Abs_Control_Inq	[1]	Capability of control with absolute value
		-	[2]	Reserved
		One_Push_Inq	[3]	One Push auto mode (controlled automatically by the camera once)
		ReadOut_Inq	[4]	Capability of reading out the value of this feature
		On_Off_Inq	[5]	Capability of switching this feature ON and OFF
		Auto_Inq	[6]	Auto Mode (controlled automatically by the camera)
		Manual_Inq	[7]	Manual Mode (controlled by user)
		Min_Value	[8..19]	Minimum value for this feature
		Max_Value	[20..31]	Maximum value for this feature

Table 68: Trigger Delay Inquiry register

	Name	Field	Bit	Description
0xF0F00834	TRIGGER_DELAY	Presence_Inq	[0]	Presence of this feature: 0: N/A 1: Available
		Abs_Control	[1]	Absolute value control 0: Control with value in the **Value** field 1: Control with value in the **Absolute** value CSR If this bit = 1, the value in the **Value** field has to be ignored
		-	[2..5]	Reserved
		ON_OFF	[6]	Write: ON or OFF this feature Read: read a status 0: OFF 1: ON In this bit = 0, other fields will be read only.
		-	[7..19]	Reserved
		Value	[20..31]	Value If you write the value in OFF mode, this field will be ignored. If **ReadOut** capability is not available, then the read value will have no meaning.

Table 69: Trigger Delay CSR

Trigger delay advanced register

In addition, the cameras have an advanced register which allows even more precise image capture delay after receiving a hardware trigger.

Register	Name	Field	Bit	Description
0xF1000400	TRIGGER_DELAY	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	-
		ON_OFF	[6]	Trigger delay on/off
		---	[7..10]	-
		DelayTime	[11..31]	Delay time in µs

Table 70: Trigger Delay Advanced CSR

The advanced register allows start of the integration to be delayed by max. 2^{21} µs, which is max. 2.1 s after a trigger edge was detected.

Note

- Switching trigger delay to ON also switches external Trigger_Mode_0 to ON.
- This feature works with external Trigger_Mode_0 only.

Exposure time

The exposure (shutter) time for continuous mode and Trigger_Mode_0 is based on the following formula:

Shutter register value x time base + offset

The register value is the value set in the corresponding IIDC 1.31 register (SHUTTER [81Ch]). This number is in the range between 1 and 4095.

The shutter register value is multiplied by the time base register value (see Table 140: Time base ID on page 287). The default value here is set to 20 µs.

A camera-specific offset is also added to this value. It is different for the camera models:

Exposure time offset

Camera model	Exposure time offset
PIKE F-032	17 µs
PIKE F-100	42 µs
PIKE F-145	38 µs
PIKE F-145-15fps	70 µs
PIKE F-210	42 µs
PIKE F-421	69 µs
PIKE F-505	26 µs

Table 71: Camera-specific exposure time offset

Minimum exposure time

Camera model	Minimum exposure time	Effective min. exp. time = Min. exp. time + offset
PIKE F-032	1 µs	1 µs + 17 µs = **18** µs
PIKE F-100	1 µs	1 µs + 42 µs = **43** µs
PIKE F-145	1 µs	1 µs + 38 µs = **39** µs
PIKE F-145-15fps	1 µs	1 µs + 70 µs = **71** µs
PIKE F-210	1 µs	1 µs + 42 µs = **43** µs
PIKE F-421	1 µs	1 µs + 69 µs = **70** µs
PIKE F-505	1 µs	1 µs + 26 µs = **27** µs

Table 72: Camera-specific minimum exposure time

Example: PIKE F-032

Camera	Register value	Time base (default)
PIKE F-032	100	20 µs

Table 73: Register value and time base for PIKE F-032

register value x time base = exposure time

100 x 20 µs + 17 µs = 2017 µs exposure time

The minimum adjustable exposure time set by register is 1 µs. → The real minimum exposure time of PIKE F-032 is then 1 µs + 17 µs = 18 µs.

Extended shutter

The exposure time for long-term integration of up to 67 seconds can be extended via the advanced register: EXTENDED_SHUTTER

Register	Name	Field	Bit	Description
0xF100020C	EXTD_SHUTTER	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1.. 5]	
		ExpTime	[6..31]	Exposure time in µs

Table 74: Extended shutter configuration

The longest exposure time, 3FFFFFFh, corresponds to 67.11 sec.

The lowest possible value of **ExpTime** is camera-specific (see Table 72: Camera-specific minimum exposure time on page 181).

Note

- Exposure times entered via the 81Ch register are mirrored in the extended register, but not vice versa.
- Longer integration times not only increase sensitivity, but may also increase some unwanted effects such as noise and pixel-to-pixel non-uniformity. Depending on the application, these effects may limit the longest usable integration time.
- Changes in this register have immediate effect, even when the camera is transmitting.
- Extended shutter becomes inactive after writing to a format/mode/frame rate register.

One-shot

The camera can record an image by setting the **one-shot bit** in the 61Ch register. This bit is automatically cleared after the image is captured. If the camera is placed in ISO_Enable mode (see Chapter ISO_Enable / Free-Run on page 186), this flag is ignored.

If **one-shot mode** is combined with the external trigger, the **one-shot** command is used to arm it. The following screenshot shows the sequence of commands needed to put the camera into this mode. It enables the camera to grab exactly one image with an external trigger edge.

If there is no trigger impulse after the camera has been armed, **one-shot** can be cancelled by clearing the bit.

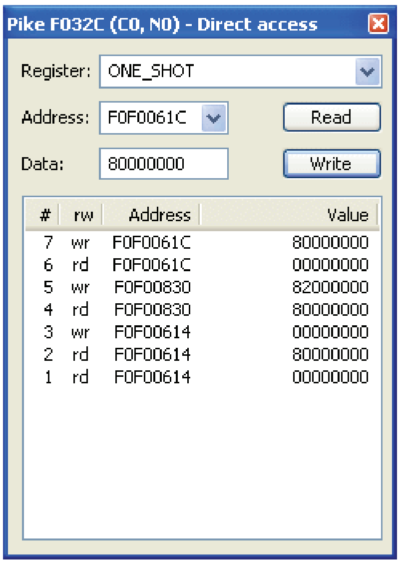


Figure 95: One-shot control (SmartView)

#	Read = rd Write = wr	Address	Value	Description
7	wr	F0F0061C	80000000	Do one-shot.
6	rd	F0F0061C	00000000	Read out one-shot register.
5	wr	F0F00830	82000000	Switch on external trigger mode 0.
4	rd	F0F00830	80000000	Check trigger status.
3	wr	F0F00614	00000000	Stop free-run.
2	rd	F0F00614	80000000	Check Iso_Enable mode (→free-run).
1	rd	F0F00614	00000000	This line is produced by SmartView.

Table 75: One-shot control: descriptions

One-shot command on the bus to start of exposure

The following sections describe the time response of the camera using a single frame (one-shot) command. As set out in the IIDC specification, this is a software command that causes the camera to record and transmit a single frame.

The following values apply only when the camera is idle and ready for use. Full resolution must also be set.

Feature	Value
One-shot → Microcontroller-Sync	≤ 150 µs (processing time in the microcontroller)
µC-Sync/ExSync → Integration-Start	8 µs

Table 76: Values for one-shot

Microcontroller-Sync is an internal signal. It is generated by the microcontroller to initiate a trigger. This can either be a direct trigger or a release for ExSync if the camera is externally triggered.

End of exposure to first packet on the bus

After the exposure, the CCD sensor is read out; some data is written into the FRAME_BUFFER before being transmitted to the bus.

The time from the end of exposure to the start of transport on the bus is:

710 µs ± 62.5 µs

This time 'jitters' with the cycle time of the bus (125 µs).

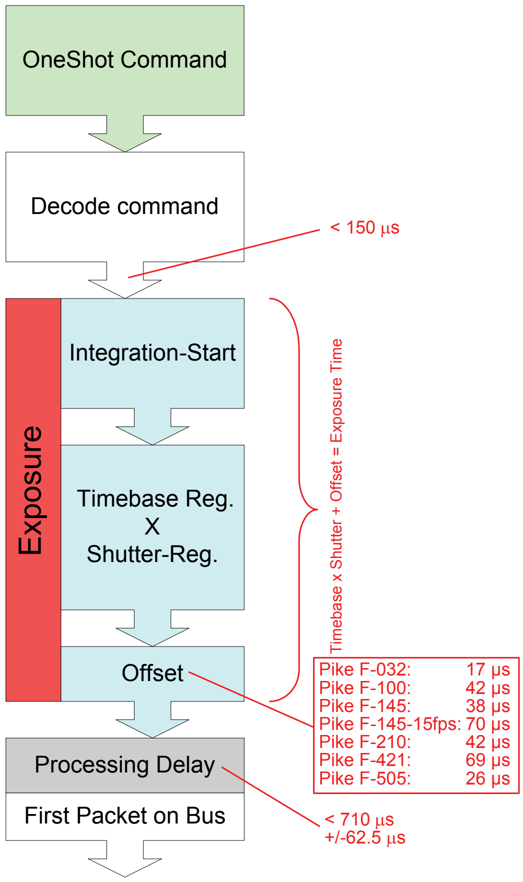


Figure 96: Data flow and timing after end of exposure

Multi-shot

Setting **multi-shot** and entering a quantity of images in **Count_Number** in the 61Ch register enables the camera to record a specified number of images.

The number is indicated in bits 16 to 31. If the camera is put into **ISO_Enable** mode (see Chapter ISO_Enable / Free-Run on page 186), this flag is ignored and deleted automatically once all the images have been recorded.

If **multi-shot** mode is activated and the images have not yet all been captured, it can be cancelled by resetting the flag. The same result can be achieved by setting the number of images to **0**.

Multi-shot can also be combined with the external trigger in order to grab a certain number of images based on an external trigger. This is especially helpful in combination with the so called **Deferred_Mode** to limit the number of grabbed images to the FIFO size.

ISO_Enable / Free-Run

Setting the MSB (bit 0) in the 614h register (ISO_ENA) puts the camera into ISO_Enable mode or Continuous_Shot. The camera captures an infinite series of images. This operation can be quit by deleting the **0** bit.

Asynchronous broadcast

The camera accepts asynchronous broadcasts. This involves asynchronous write requests that use node number 63 as the target node with no acknowledge.

This makes it possible for all cameras on a bus to be triggered by software simultaneously - e.g. by broadcasting a **One_Shot**. All cameras receive the **One_Shot** command in the same IEEE 1394 bus cycle. This creates uncertainty for all cameras in the range of 125 µs.

Inter-camera latency is described in Chapter Jitter at start of exposure on page 187.

The following screenshot shows an example of broadcast commands sent with the Firedemo example of FirePackage:

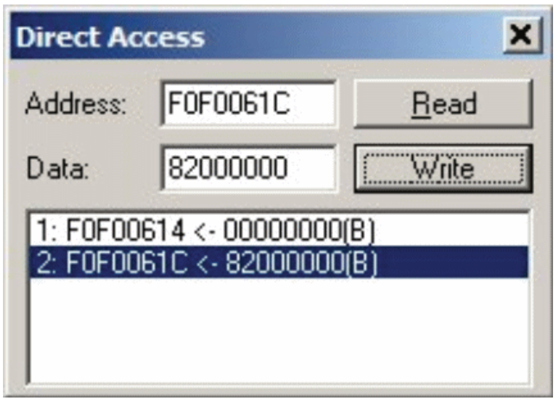


Figure 97: Broadcast one-shot

- Line 1 shows the broadcast command, which stops all cameras connected to the same IEEE 1394 bus. It is generated by holding the <shift> key down while clicking on <Write>.
- Line 2 generates a **broadcast One_Shot** in the same way, which forces all connected cameras to simultaneously grab one image.

Jitter at start of exposure

The following chapter discusses the latency time which exists for all CCD models when either a hardware or software trigger is generated, until the actual image exposure starts.

Owing to the well-known fact that an Interline Transfer CCD sensor has both a light sensitive area and a separate storage area, it is common to interleave image exposure of a new frame and output that of the previous one. It makes continuous image flow possible, even with an external trigger.

The uncertain time delay before the start of exposure depends on the state of the sensor. A distinction is made as follows:

FVal is active → the sensor is reading out, the camera is busy

In this case the camera must not change horizontal timing so that the trigger event is synchronized with the current horizontal clock. This introduces a max. uncertainty which is equivalent to the line time. The line time depends on the sensor used and therefore can vary from model to model.

FVal is inactive → the sensor is ready, the camera is idle

In this case the camera can resynchronize the horizontal clock to the new trigger event, leaving only a very short uncertainty time of the master clock period.

Model	Exposure start jitter (while FVal)	Exposure start jitter (while camera idle)
Pike F-032	± 4.9 µs	± 375 ns
Pike F-100	± 8.2 µs	± 1.65 µs
Pike F-145	± 16 µs	± 2.9 µs
Pike F-145-15fps	± 30 µs	± 5.4 µs
Pike F-210	± 14.25 µs	± 1.8 µs
Pike F-421	± 15 µs	± 1.65 µs
Pike F-505	± 17 µs	± 5.7 µs

Table 77: Jitter at exposure start (no binning, no sub-sampling)

Note

- Jitter at the beginning of an exposure has no effect on the length of exposure, i.e. it is always constant.

Sequence mode

Generally all AVT Pike cameras enable certain image settings to be modified on the fly, e.g. gain and shutter can be changed by the host computer by writing into the gain and shutter register even while the camera is running. An uncertainty of up to 3 images remains because normally the host does not know (especially with external trigger) when the next image will arrive.

Sequence mode is a different concept where the camera holds a set of different image parameters for a sequence of images. The parameter set is stored volatile in the camera for each image to be recorded. This sequence of parameter sets is simply called a sequence. The advantage is that the camera can easily synchronize this parameter set with the images so that no uncertainty can occur. All AVT Pike cameras support 32 different sequence parameters.

Additionally to the sequence mode known from Marlin cameras, the Pike cameras have:

- Repeat counter per sequence item
- Incrementing list pointer on input status (on/off)
- Pointer reset (software command; on input pin)

Examples

For a sequence of images, each image can be recorded with a different shutter or gain to obtain different brightness effects.

The image area (AOI) of a sequence of images can automatically be modified, thus creating a panning or sequential split screen effect.

The following registers can be modified to affect the individual steps of the sequence. Different configurations can be accessed via e.g a footswitch which is connected to an input.

Mode	this registers can be modified...
All modes	Cur_V_Mode, Cur_V_Format, ISO_Channel, ISO_Speed, Brightness, White_Balance (color cameras only), Shutter, Gain, LUT, TestImage, Image-Mirror, HSNR, Output-Ctrl, ColorCorrection matrix (color cameras only), ISO-Channel, Shading-Ctrl, Sequence-Stepping Mode, SIS_UserValue
Fixed modes only	Cur_V_Frm_Rate
Format_7 only	Image_Position (AOI-Top, AOI-Left), Image_Size (AOI-Width, AOI-Height), Color_Coding_ID*, Binning*, Sub-Sampling*, Byte_Per_Packet *hidden in video formats and video modes

Table 78: Registers to be modified within a sequence

Note

Sequence mode requires not only firmware 3.x but also special care if changing image size, Color_Coding_ID and frame rate related parameters. This is because these changes not only affect settings in the camera but also require corresponding settings in the receiving software in the PC.

Caution

Incorrect handling may lead to **image corruption** or **loss of subsequent images**.

Please ask for detailed support when you want to use this feature.

How is sequence mode implemented?

There is a FIFO (first in first out) memory for each of the IIDC V1.31 registers listed above. The depth of each FIFO is fixed to 32(dez) complete sets. Functionality is controlled by the following advanced registers.

Register	Name	Field	Bit	Description
0xF1000220	SEQUENCE_CTRL	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..4]	Reserved
		AutoRewind	[5]	
		ON_OFF	[6]	Enable/disable this feature
		SetupMode	[7]	Sequence setup mode
		---	[8..15]	Reserved
		MaxLength	[16..23]	Maximum possible length of a sequence (read only)
		SeqLength	[24..31]	Length of the sequence (32 dez for all CCD models)
0xF1000224	SEQUENCE_PARAM	---	[0..4]	Reserved
		ApplyParameters	[5]	Apply settings to selected image of sequence; auto-reset
		---	[6..7]	Reserved
		SeqStepMode	[8..15]	Sequence stepping mode
		ImageRepeat	[16..23]	Image repeat counter
		ImageNo	[24..31]	Number of image within a sequence

Table 79: Sequence configuration register

Register	Name	Field	Bit	Description
0xF1000228	SEQUENCE_STEP	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..4]	Reserved
		PerformStep	[5]	Sequence is stepped one item forward
		PerformReset	[6]	Sequence reset
		---	[7..23]	Reserved
		SeqPosition	[24..31]	Get the current sequence position
0xF100022C	SEQUENCE_RESET	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..4]	Reserved
		PerformReset	[5]	Reset the sequence to start position
		---	[6..31]	Reserved

Table 79: Sequence configuration register

Enabling this feature turns the camera into a special mode. This mode can be used to set up a bunch of parameter sets for up to **MaxLength** consecutive images. The sequence mode of the Pike 3.x series firmware behaves slightly different than the sequence mode of e.g. the Marlin series and implements some new controlling features. You may use a sequence with internal or external trigger and with the **Deferred Transport** feature.

Setup mode (new for 3.x)

The **SetupMode** flag allows you to set up a sequence while capturing images. Using this flag you get a visual feedback of the settings.

Set **SetupMode** flag when setting up the sequence and reset the flag before using the sequence.

Sequence step mode (new for 3.x)

The SeqMode field selects the signal source for stepping the sequence one parameter set further.

SeqMode description

Seqence mode	Description
0x80	This mode is the default sequence mode and stepping the sequence is compatible to e.g. the Marlin series. With each image integration start the sequence is stepped one item further and the new parameter set becomes active for the next image.
0x82	Stepping of the sequence is controlled by a **rising edge** of an **external signal**. The new parameter set becomes active with the next integration start. When using this mode select the suitable input mode of the input lines.
0x84	Stepping of the sequence is controlled by a **high level** of an **external signal**. The new parameter set becomes active with the next integration start. When using this mode select the suitable input mode of the input lines.
Other mode	Choosing any other mode value, automatically defaults to mode 0x80.

Table 80: Sequence mode description

Note

It is also possible, that a sequence consists of parameter sets with different sequence modes. This can be achieved by using the SeqMode and the ImageNo fields within the Sequence_Param register.

Sequence repeat counter (new for 3.x)

For each parameter set one can define an image repeat counter. Using the image repeat counter means that a parameter set can be used for n consecutive images before the next parameter set is applied.

Setting the **ImageRepeat** field to 0 has the same effect like setting this field to 1.

Manual stepping & reset (new for 3.x)

With firmware 3.x a sequence can be stepped further with a software command. To use manual stepping use stepping mode 0x82 or 0x84, but dont setup any input pin for external sequence stepping.

Every time the **PerformStep** flag is set the sequence will be stepped one parameter set further. Manual stepping observes the repeat counter also.

For some application it could be useful to reset the sequence during runtime. Simply set the **PerformReset** flag to one: the sequence starts over with the very first parameter set.

The following flow diagram shows how to set up a sequence.

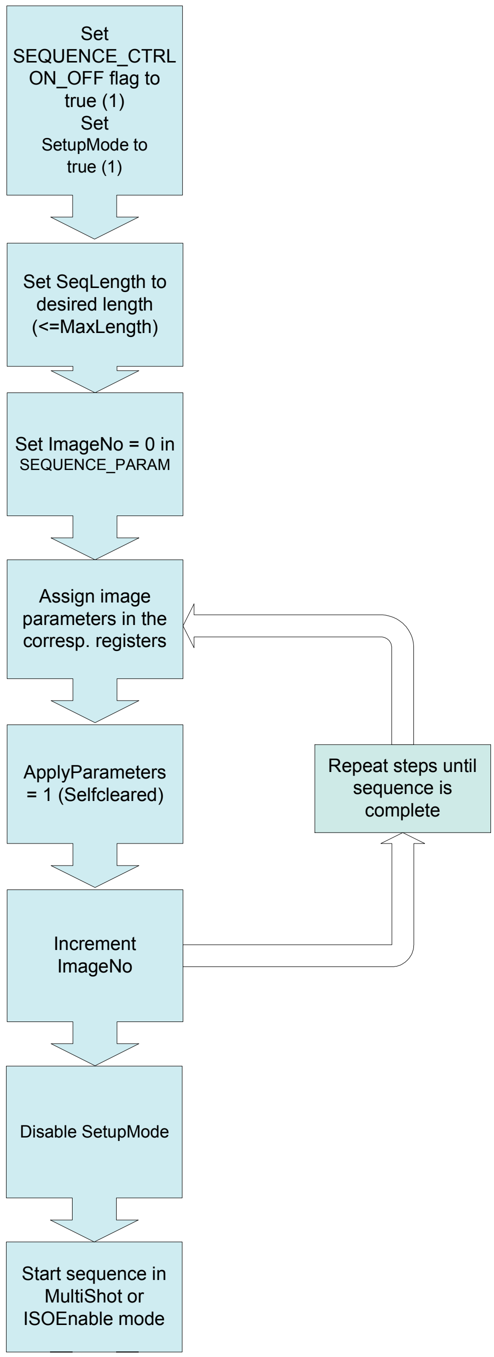


Figure 98: Sequence mode flow diagram

During sequencing, the camera obtains the required parameters, image by image, from the corresponding FIFOs (e.g. information for exposure time).

Which new sequence mode features are available?

New features:

- Repeat one step of a sequence n times where n can be set by the variable **ImageRepeat** in SEQUENCE_PARAM.
- Define one or two hardware inputs in Input mode field of IO_INP_CTRL as:
  - Sequence step input (if two are set as input, they are AND gated) or
  - Sequence reset input

Note

From now on:

sequence step is **I/O controlled sequence stepping mode**

sequence reset is **I/O controlled sequence pointer reset**

Setup mode

The **SetupMode** flag allows you to set up a sequence while capturing images. Using this flag you get a visual feedback of the settings. Set this flag when setting up the sequence and reset the flag before using the sequence.

I/O controlled sequence stepping mode

The **I/O controlled sequence stepping mode** can be done level controlled or edge controlled:

Level controlled	Edge controlled
• As long as the input is in high state the sequence pointer will be incremented from image to image. • Can be combined with **Quick Format Change Modes**. See Chapter Standard Parameter Update Timing on page 152 and Chapter New: Quick Format Change Mode (QFCM) on page 152. • Level change is asynchronous to image change.	• A rising edge on the input will cause one pointer increment immediately. • Can be combined with **Quick Format Change Modes**. See Chapter Standard Parameter Update Timing on page 152 and Chapter New: Quick Format Change Mode (QFCM) on page 152.

Table 81: Description of sequence stepping control

The **I/O controlled sequence stepping mode** can be set for ervery single sequence entry. Thus a sequence can be controlled in a very flexible manner.

I/O controlled sequence pointer reset

I/O controlled sequence pointer reset is always edge controlled. A rising edge on the input pin resets the pointer to the first entry.

I/O controlled sequence pointer reset can be combined with **Quick Format Change Modes**. See Chapter Standard Parameter Update Timing on page 152 and Chapter New: Quick Format Change Mode (QFCM) on page 152.

I/O controlled sequence stepping mode and I/O controlled sequence pointer reset via software command

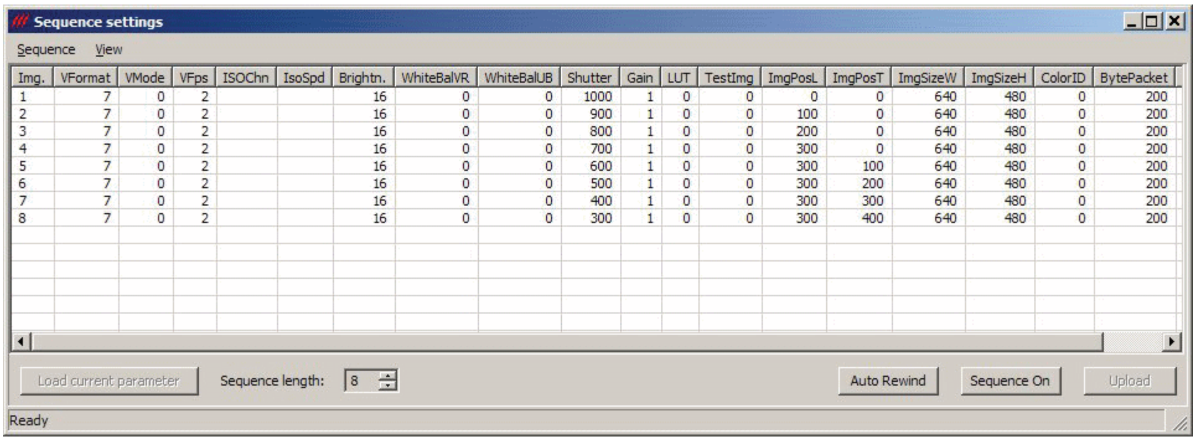
Both sequence modes can be controlled via software command.

Points to pay attention to when working with a sequence

Note

- If more images are recorded than defined in **SeqLength**, the settings for the last image remain in effect.
- If **sequence** mode is cancelled, the camera can use the FIFO for other tasks. For this reason, a sequence must be loaded back into the camera after **sequence** mode has been cancelled.
- To repeat the sequence, stop the camera and send the **multi-shot** or **IsoEnable** command again. Each of these two commands resets the sequence.
- Using **SingleShot** mode in combination with a sequence does not make sense, because **SingleShot** mode restarts the sequence every time.
- The sequence may not be active when setting the AutoRewind flag. For this reason it is important to set the flag before the **multi-shot** or **IsoEnable** commands.
- If the sequence is used with the **deferred transport** feature, the number of images entered in **Seq_Length** may not be exceeded.

The following screenshot shows an example of a sequence for eight different image settings. It uses the **AVT Firetool program** as graphical representation. Please note the changes in the shutter time; that creates descending image brightness, and the change in the image position; which creates a panning effect.



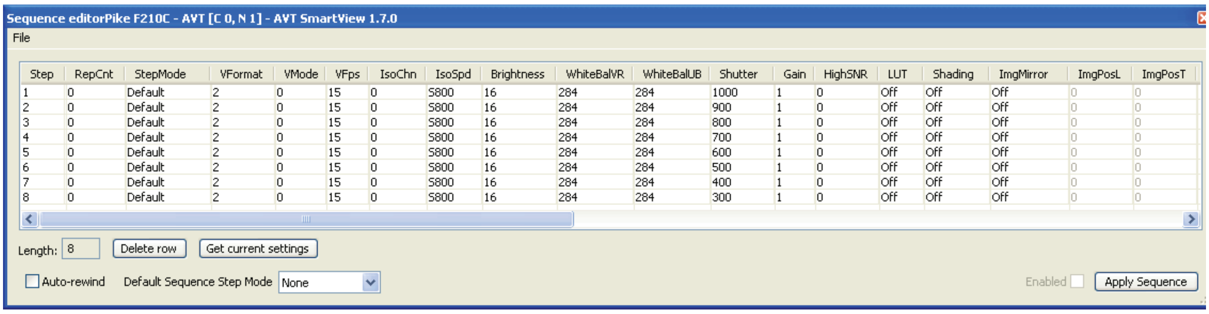
Img.	VFormat	VMode	VFps	ISOChn	IsoSpd	Brightn.	WhiteBalVR	WhiteBalUB	Shutter	Gain	LUT	TestImg	ImgPosL	ImgPosT	ImgSizeW	ImgSizeH	ColorID	BytePacket
1	7	0	2			16	0	0	1000	1	0	0	0	0	640	480	0	200
2	7	0	2			16	0	0	900	1	0	0	100	0	640	480	0	200
3	7	0	2			16	0	0	800	1	0	0	200	0	640	480	0	200
4	7	0	2			16	0	0	700	1	0	0	300	0	640	480	0	200
5	7	0	2			16	0	0	600	1	0	0	300	100	640	480	0	200
6	7	0	2			16	0	0	500	1	0	0	300	200	640	480	0	200
7	7	0	2			16	0	0	400	1	0	0	300	300	640	480	0	200
8	7	0	2			16	0	0	300	1	0	0	300	400	640	480	0	200

Figure 99: Example of sequence mode settings

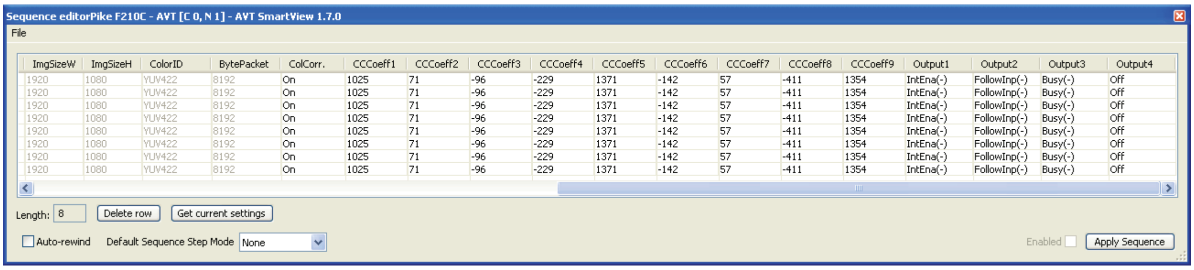
Instead of **Firetool** you also can use **SmartView** (Version 1.7.0 or greater), but image and transfer formats have to be unchanged (height, width, ColorID).

To open the **Sequence editor** in SmartView:

1. Click **Extras** → **Sequence dialog**



Step	RepCnt	StepMode	VFormat	VMode	VFps	IsoChn	IsoSpd	Brightness	WhiteBalVR	WhiteBalUB	Shutter	Gain	HighSNR	LUT	Shading	ImgMirror	ImgPosL	ImgPosT
1	0	Default	2	0	15	0	S800	16	284	284	1000	1	0	Off	Off	Off	0	0
2	0	Default	2	0	15	0	S800	16	284	284	900	1	0	Off	Off	Off	0	0
3	0	Default	2	0	15	0	S800	16	284	284	800	1	0	Off	Off	Off	0	0
4	0	Default	2	0	15	0	S800	16	284	284	700	1	0	Off	Off	Off	0	0
5	0	Default	2	0	15	0	S800	16	284	284	600	1	0	Off	Off	Off	0	0
6	0	Default	2	0	15	0	S800	16	284	284	500	1	0	Off	Off	Off	0	0
7	0	Default	2	0	15	0	S800	16	284	284	400	1	0	Off	Off	Off	0	0
8	0	Default	2	0	15	0	S800	16	284	284	300	1	0	Off	Off	Off	0	0



ImgSizeW	ImgSizeH	ColorID	BytePacket	ColCorr.	CCCoeff1	CCCoeff2	CCCoeff3	CCCoeff4	CCCoeff5	CCCoeff6	CCCoeff7	CCCoeff8	CCCoeff9	Output1	Output2	Output3	Output4
1920	1080	YUV422	8192	On	1025	71	-96	-229	1371	-142	57	-411	1354	IntEna(-)	FollowInp(-)	Busy(-)	Off
1920	1080	YUV422	8192	On	1025	71	-96	-229	1371	-142	57	-411	1354	IntEna(-)	FollowInp(-)	Busy(-)	Off
1920	1080	YUV422	8192	On	1025	71	-96	-229	1371	-142	57	-411	1354	IntEna(-)	FollowInp(-)	Busy(-)	Off
1920	1080	YUV422	8192	On	1025	71	-96	-229	1371	-142	57	-411	1354	IntEna(-)	FollowInp(-)	Busy(-)	Off
1920	1080	YUV422	8192	On	1025	71	-96	-229	1371	-142	57	-411	1354	IntEna(-)	FollowInp(-)	Busy(-)	Off
1920	1080	YUV422	8192	On	1025	71	-96	-229	1371	-142	57	-411	1354	IntEna(-)	FollowInp(-)	Busy(-)	Off
1920	1080	YUV422	8192	On	1025	71	-96	-229	1371	-142	57	-411	1354	IntEna(-)	FollowInp(-)	Busy(-)	Off
1920	1080	YUV422	8192	On	1025	71	-96	-229	1371	-142	57	-411	1354	IntEna(-)	FollowInp(-)	Busy(-)	Off

Figure 100: SmartView: **Extras** → **Sequence dialog**

Changing the parameters within a sequence

To change the parameter set for one image, it is not necessary to modify the settings for the entire sequence. The image can simply be selected via the **ImageNo** field and it is then possible to change the corresponding IIDC V1.31 registers.

Points to pay attention to when changing the parameters

Note

- If the **ApplyParameters** flag is used when setting the parameters, all not-configured values are set to default values. As changing a sequence normally affects only the value of a specific register, and all other registers should not be changed, the **ApplyParameters** flag may not be used here.
- The values stored for individual images can no longer be read.
- If the camera is switched into **sequence mode**, the changes to the IIDC V1.31 registers for the image specified in **ImageNo** take immediate effect.
- Sequence mode requires firmware 3.x and special care if changing image size and frame rate related parameters. This is because these changes not only affect settings in the camera but also require corresponding settings in the receiving software in the PC (e.g. FirePackage).

Caution

Incorrect handling may lead to **image corruption** or **loss of subsequent images**.

Please ask for detailed support when you want to use this feature.

Secure image signature (SIS): definition and scenarios

Note

For all customers who know SIS from MARLIN cameras:

- PIKE cameras have **additional SIS features**: AOI, exposure/gain, input/output state, index of sequence mode and serial number.
- In contrary to MARLIN cameras, in the PIKE SIS feature the **endianness cannot be changed**.

SIS: Definition

Secure image signature (SIS) is the synonym for data, which is inserted into an image to improve or check image integrity.

With the new firmware 3.x, all PIKE models can insert

- Time stamp (1394 bus cycle time at the beginning of integration)
- Trigger counter (external trigger seen only)
- Frame counter (frames read out of the sensor)
- AOI (x, y, width, height)
- Exposure (shutter) and gain
- Input and output state on exposure start
- Index of sequence mode
- Serial number
- User value

into a selectable line position within the image. Furthermore the trigger counter and the frame counter are available as advanced registers to be read out directly.

SIS: Scenarios

The following scenarios benefit from this feature:

- Assuming camera runs in **continuous mode**, the check of monotonically changing bus cycle time is a simple test that no image was skipped or lost in the camera or subsequently in the image processing chain.
- In (synchronized) **multi camera applications**, the time stamp can be used to identify those images, shot at the same moment in time.
- The cross-check of the frame counter of the camera against the frame counter of the host system also identifies any **skipped or lost images** during transmission.
- The cross-check of the trigger counter against the frame counter in the camera can identify a **trigger overrun** in the camera.

- AOI can be inserted in the image if it was set as a variable e.g. in a sequence.
- Exposure/gain scenario parameters can be inserted in the image if set as a variable in e.g. sequence mode to identify the imaging conditions.
- Inserting input and output state on exposure start can be helpful when working with input and output signals.
- Index of sequence mode can be inserted if SIS is used together with sequence mode.
- Serial number inserted in the image helps to document/identify the camera in e.g. multi camera applications.

Note

- FirePackage offers additional and independent checks to be performed for the purpose of image integrity. Details can be found in the respective documentation.

The handling of the SIS feature is fully described in the Chapter Secure image signature (SIS) on page 312.

Smear reduction

Smear reduction: definition

Definition **Smear** is an undesirable CCD sensor artefact creating a vertical bright line that extends above and below a bright spot in an image.

Definition **Smear reduction** is a new feature of PIKE cameras: it is a function implemented in hardware in the camera itself to compensate for smear.

Smear reduction: how it works

To reduce smear a reference line is used. This reference line is built from the mean value of the so-called **black lines** (two lines before image start). The reference line is subtracted from every line of the whole image.

But how will this reduce smearing?

The point is: black lines have no image information but are also affected from smearing. Thus the smearing effect itself is isolated and can be reduced in the whole image.

The two additional black lines and the calculated anti-smear values do not lower the transfer rates significantly due to hardware implementation.

Smear reduction: switch on/off in register and SmartView

To switch on/off smear reduction in advanced registers, see Chapter Smear reduction on page 317.

In SmartView: **Edit settings → Adv3** tab (Smear reduction ☑ **Enable**)

Video formats, modes and bandwidth

The different PIKE models support different video formats, modes and frame rates.

These formats and modes are standardized in the IIDC (formerly DCAM) specification.

Resolutions smaller than the generic sensor resolution are generated from the center of the sensor and without binning.

Note

- The maximum frame rates can only be achieved with shutter settings lower than 1/framerate. This means that with default shutter time of 40 ms, a camera will not achieve frame rates higher than 25 frames/s. In order to achieve higher frame rates, please reduce the shutter time proportionally.
- The following tables assume that bus speed is 800 Mbit/s. With lower bus speeds (e.g. 400, 200 or 100 Mbit/s) not all frame rates may be achieved.

PIKE F-032B / PIKE F-032C

Format	Mode	Resolution	Color mode	240 fps	120 fps	60 fps	30 fps	15 fps	7.5 fps	3.75 fps	1.875 fps
0	0	160 x 120	YUV444								
	1	320 x 240	YUV422		x	x	x	x	x	x	x
	2	640 x 480	YUV411		x	x	x	x	x	x	x
	3	640 x 480	YUV422			x	x	x	x	x	x
	4	640 x 480	RGB8			x	x	x	x	x	x
	5	640 x 480	Mono8		x x*	x x*	x x*	x x*	x x*	x x*	x x*
	6	640 x 480	Mono16			x	x	x	x	x	x

Table 82: Video fixed formats PIKE F-032B / PIKE F-032C

*: Color camera outputs RAW image, which needs to be converted outside of camera.

Frame rates with shading are only achievable with 1394b (S800).

Format	Mode	Resolution	Color mode	Maximal S800 frame rates for Format_7 modes
7	0	640 x 480	Mono8 Mono12 Mono16	208 fps 139 fps 105 fps
		640 x 480	YUV411 YUV422,Raw16 Mono8,Raw8 RGB8	139 fps 105 fps 208 fps 70 fps
	1	320 x 480	Mono8 Mono12 Mono16	208 fps 2x H-binning 208 fps 2x H-binning 208 fps 2x H-binning
	2	640 x 240	Mono8 Mono12 Mono16	372 fps 2x V-binning 271 fps 2x V-binning 208 fps 2x V-binning
	3	320 x 240	Mono8 Mono12 Mono16	372 fps 2x H+V binning 372 fps 2x H+V binning 372 fps 2x H+V binning
	4	320 x 480	Mono8 Mono12 Mono16	208 fps 2 out of 4 H-sub-sampling 208 fps 2 out of 4 H-sub-sampling 208 fps 2 out of 4 H-sub-sampling
		320 x 480	YUV411 YUV422,Raw16 Mono8,Raw8 RGB8	208 fps 2 out of 4 H-sub-sampling 208 fps 2 out of 4 H-sub-sampling 208 fps 2 out of 4 H-sub-sampling 139 fps 2 out of 4 H-sub-sampling
	5	320 x 240	Mono8 Mono12 Mono16	372 fps 2 out of 4 V-sub-sampling 372 fps 2 out of 4 V-sub-sampling 372 fps 2 out of 4 V-sub-sampling
		320 x 240	YUV411 YUV422,Raw16 Mono8,Raw8 RGB8	372 fps 2 out of 4 V-sub-sampling 372 fps 2 out of 4 V-sub-sampling 372 fps 2 out of 4 V-sub-sampling 271 fps 2 out of 4 V-sub-sampling
	6	320 x 240	Mono8 Mono12 Mono16	372 fps 2 out of 4 H+V sub-sampling 372 fps 2 out of 4 H+V sub-sampling 372 fps 2 out of 4 H+V sub-sampling
		320 x 240	YUV411 YUV422,Raw16 Mono8,Raw8 RGB8	372 fps 2 out of 4 H+V sub-sampling 372 fps 2 out of 4 H+V sub-sampling 372 fps 2 out of 4 H+V sub-sampling 271 fps 2 out of 4 H+V sub-sampling

Table 83: Video Format_7 default modes PIKE F-032B / PIKE F-032C

PIKE F-100B / PIKE F-100C

Format	Mode	Resolution	Color mode	240 fps	120 fps	60 fps	30 fps	15 fps	7.5 fps	3.75 fps	1.875 fps
0	0	160 x 120	YUV444								
	1	320 x 240	YUV422		x	x	x	x	x	x	x
	2	640 x 480	YUV411			x	x	x	x	x	x
	3	640 x 480	YUV422			x	x	x	x	x	x
	4	640 x 480	RGB8			x	x	x	x	x	x
	5	640 x 480	Mono8			xx*	x x*	x x*	x x*	x x*	x x*
	6	640 x 480	Mono16			x	x	x	x	x	x
1	0	800 x 600	YUV422			x	x	x	x	x	
	1	800 x 600	RGB8				x	x	x		
	2	800 x 600	Mono8			x x*	x x*	x x*	x x*		
	3	1024 x 768	YUV422								
	4	1024 x 768	RGB8								
	5	1024 x 768	Mono8								
	6	800 x 600	Mono16			x	x	x	x	x	
	7	1024 x 768	Mono16								

Table 84: Video fixed formats PIKE F-100B / F-100C

*: Color camera outputs RAW image, which needs to be converted outside of camera.

Format	Mode	Resolution	Color mode	Maximal S800 frame rates for Format_7 modes	
7	0	1000 x 1000	Mono8 Mono12 Mono16	60 fps 43 fps 33 fps	
		1000 x 1000	YUV411 YUV422,Raw16 Mono8,Raw8 RGB8	43 fps 33 fps 60 fps 22 fps	
	1	500 x 1000	Mono8 Mono12 Mono16	60 fps 60 fps 60 fps	2x H-binning 2x H-binning 2x H-binning
	2	1000 x 500	Mono8 Mono12 Mono16	99 fps 86 fps 65 fps	2x V-binning 2x V-binning 2x V-binning
	3	500 x 500	Mono8 Mono12 Mono16	99 fps 99 fps 99 fps	2x H+V binning 2x H+V binning 2x H+V binning
	4	500 x 1000	Mono8 Mono12 Mono16	60 fps 60 fps 60 fps	2x H-sub-sampling 2x H-sub-sampling 2x H-sub-sampling
		500 x 1000	YUV411 YUV422,Raw16 Mono8,Raw8 RGB8	60 fps 60 fps 60 fps 43 fps	2 out of 4 H-sub-sampling 2 out of 4 H-sub-sampling 2 out of 4 H-sub-sampling 2 out of 4 H-sub-sampling
	5	1000 x 500	Mono8 Mono12 Mono16	99 fps 86 fps 65 fps	2x V-sub-sampling 2x V-sub-sampling 2x V-sub-sampling
		1000 x 500	YUV411 YUV422,Raw16 Mono8,Raw8 RGB8	86 fps 65 fps 99 fps 43 fps	2 out of 4 V-sub-sampling 2 out of 4 V-sub-sampling 2 out of 4 V-sub-sampling 2 out of 4 V-sub-sampling
	6	500 x 500	Mono8 Mono12 Mono16	99 fps 99 fps 99 fps	2x H+V-sub-sampling 2x H+V-sub-sampling 2x H+V-sub-sampling
		500 x 500	YUV411 YUV422,Raw16 Mono8,Raw8 RGB8	99 fps 99 fps 99 fps 86 fps	2 out of 4 H+V-sub-sampling 2 out of 4 H+V-sub-sampling 2 out of 4 H+V-sub-sampling 2 out of 4 H+V-sub-sampling

Table 85: Video Format_7 default modes PIKE F-100B / F-100C

PIKE F-145B / PIKE F-145C (-15 fps**)

**Pike F-145-15fps cameras have frame rates up to 15 fps only (except color cameras Format_0 Mode_1: up to 30 fps).

Format	Mode	Resolution	Color mode	240 fps	120 fps	60 fps	30 fps	15 fps	7.5 fps	3.75 fps	1.875 fps
0	0	160 x 120	YUV444								
	1	320 x 240	YUV422			x	x	x	x	x	x
	2	640 x 480	YUV411				x	x	x	x	x
	3	640 x 480	YUV422				x	x	x	x	x
	4	640 x 480	RGB8				x	x	x	x	x
	5	640 x 480	Mono8				x x*	x x*	x x*	x x*	x x*
	6	640 x 480	Mono16				x	x	x	x	x
1	0	800 x 600	YUV422				x	x	x	x	
	1	800 x 600	RGB8				x	x	x		
	2	800 x 600	Mono8				x x*	x x*	x x*		
	3	1024 x 768	YUV422				x	x	x	x	x
	4	1024 x 768	RGB8					x	x	x	x
	5	1024 x 768	Mono8				x x*	x x*	x x*	x x*	x x*
	6	800 x 600	Mono16				x	x	x	x	
	7	1024 x 768	Mono16				x	x	x	x	x
2	0	1280 x 960	YUV422					x	x	x	x
	1	1280 x 960	RGB8					x	x	x	x
	2	1280 x 960	Mono 8				x x*	x x*	x x*	x x*	x x*
	3	1600 x 1200	YUV422								
	4	1600 x 1200	RGB8								
	5	1600 x 1200	Mono8								
	6	1280 x 960	Mono16					x	x	x	x
	7	1600 x 1200	Mono16								

Table 86: Video fixed formats PIKE F-145B / F-145C

*: Color camera outputs RAW image, which needs to be converted outside of camera.

Frame rates with shading are only achievable with 1394b (S800).

Format	Mode	Resolution	Color mode	Maximal S800 frame rates for Format_7 modes	
7	0	1388 x 1038	Mono8	30 (16**) fps	
			Mono12	30 (16**) fps	
			Mono16	23 (16**) fps	
		1388 x 1038	YUV411	30 (16**) fps	
			YUV422,Raw16	23 (16**) fps	
			Mono8,Raw8	30 (16**) fps	
			RGB8	15 (15**) fps	
	1	692 x 1038	Mono8	30 (16**) fps	2x H-binning
			Mono12	30 (16**) fps	2x H-binning
			Mono16	30 (16**) fps	2x H-binning
	2	1388 x 518	Mono8	51 (27**) fps	2x V-binning
			Mono12	51 (27**) fps	2x V-binning
			Mono16	45 (27**) fps	2x V-binning
	3	692 x 518	Mono8	51 (27**) fps	2x H+V binning
			Mono12	51 (27**) fps	2x H+V binning
			Mono16	51 (27**) fps	2x H+V binning
	4	692 x 1038	Mono8	30 (16**) fps	2 out of 4 H-sub-sampling
			Mono12	30 (16**) fps	2 out of 4 H-sub-sampling
			Mono16	30 (16**) fps	2 out of 4 H-sub-sampling
		692 x 1038	YUV411	30 (16**) fps	2 out of 4 H-sub-sampling
			YUV422,Raw16	30 (16**) fps	2 out of 4 H-sub-sampling
			Mono8,Raw8	30 (16**) fps	2 out of 4 H-sub-sampling
			RGB8	30 (16**) fps	2 out of 4 H-sub-sampling
	5#	1388 x 518	Mono8	30 (16**) fps	2 out of 4 V-sub-sampling
			Mono12	30 (16**) fps	2 out of 4 V-sub-sampling
			Mono16	23 (16**) fps	2 out of 4 V-sub-sampling
		1388 x 518	YUV411	30 (16**) fps	2 out of 4 V-sub-sampling
			YUV422,Raw16	23 (16**) fps	2 out of 4 V-sub-sampling
			Mono8,Raw8	30 (16**) fps	2 out of 4 V-sub-sampling
			RGB8	15 (15**) fps	2 out of 4 V-sub-sampling
	6#	692 x 518	Mono8	30 (16**) fps	2 out of 4 H+V-sub-sampling
			Mono12	30 (16**) fps	2 out of 4 V-sub-sampling
			Mono16	30 (16**) fps	2 out of 4 H+V-sub-sampling
		692 x 518	YUV411	30 (16**) fps	2 out of 4 H+V-sub-sampling
			YUV422,Raw16	30 (16**) fps	2 out of 4 H+V-sub-sampling
			Mono8,Raw8	30 (16**) fps	2 out of 4 H+V-sub-sampling
			RGB8	30 (16**) fps	2 out of 4 H+V-sub-sampling

Table 87: Video Format_7 default modes PIKE F-145B / F-145C

#: Vertical sub-sampling is done via concealing certain lines, so the frame rate is not
frame rate = f (AOI height)
but
frame rate = f (2 x AOI height)

** applying to -15fps variant only

PIKE F-210B / PIKE F-210C

Format	Mode	Resolution	Color mode	240 fps	120 fps	60 fps	30 fps	15 fps	7.5 fps	3.75 fps	1.875 fps
0	0	160 x 120	YUV444								
	1	320 x 240	YUV422			x	x	x	x	x	x
	2	640 x 480	YUV411				x	x	x	x	x
	3	640 x 480	YUV422				x	x	x	x	x
	4	640 x 480	RGB8				x	x	x	x	x
	5	640 x 480	Mono 8				x x*	x x*	x x*	x x*	x x*
	6	640 x 480	Mono 16				x	x	x	x	x
1	0	800 x 600	YUV422				x	x	x	x	
	1	800 x 600	RGB8				x	x	x		
	2	800 x 600	Mono8				x x*	x x*	x x*		
	3	1024 x 768	YUV422				x	x	x	x	x
	4	1024 x 768	RGB8					x	x	x	x
	5	1024 x 768	Mono 8				x x*	x x*	x x*	x x*	x x*
	6	800 x 600	Mono16				x	x	x	x	
	7	1024 x 768	Mono16				x	x	x	x	x
2	0	1280 x 960	YUV422					x	x	x	x
	1	1280 x 960	RGB8					x	x	x	x
	2	1280 x 960	Mono 8				x x*	x x*	x x*	x x*	x x*
	3	1600 x 1200	YUV422								
	4	1600 x 1200	RGB8								
	5	1600 x 1200	Mono8								
	6	1280 x 960	Mono16					x	x	x	x
	7	1600 x 1200	Mono16								

Table 88: Video fixed formats PIKE F-210B / F-210C

*: Color camera outputs RAW image, which needs to be converted outside of camera.

Frame rates with shading are only achievable with 1394b (S800).

Format	Mode	Resolution	Color mode	Maximal S800 frame rates for Format_7 modes	
7	0	1920 x 1080	Mono8	31 fps	
			Mono12	21 fps	
			Mono16	16 fps	
		1920 x 1080	YUV411	21 fps	
			YUV422,Raw16	16 fps	
			Mono8,Raw8	31 fps	
			RGB8	11 fps	
	1	960 x 1080	Mono8	32 fps	2x H-binning
			Mono12	32 fps	2x H-binning
			Mono16	31 fps	2x H-binning
	2	1920 x 540	Mono8	52 fps	2x V-binning
			Mono12	42 fps	2x V-binning
			Mono16	31 fps	2x V-binning
	3	960 x 540	Mono8	52 fps	2x H+V binning
			Mono12	52 fps	2x H+V binning
			Mono16	52 fps	2x H+V binning
	4	960 x 1080	Mono8	32 fps	2x H-sub-sampling
			Mono12	32 fps	2x H-sub-sampling
			Mono16	31 fps	2x H-sub-sampling
		960 x 1080	YUV411	32 fps	2 out of 4 H-sub-sampling
			YUV422,Raw16	31 fps	2 out of 4 H-sub-sampling
			Mono8,Raw8	32 fps	2 out of 4 H-sub-sampling
			RGB8	21 fps	2 out of 4 H-sub-sampling
	5#	1920 x 540	Mono8	31 fps	2x V-sub-sampling
			Mono12	21 fps	2x V-sub-sampling
			Mono16	16 fps	2x V-sub-sampling
		1920 x 540	YUV411	21 fps	2 out of 4 V-sub-sampling
			YUV422,Raw16	16 fps	2 out of 4 V-sub-sampling
			Mono8,Raw8	31 fps	2 out of 4 V-sub-sampling
			RGB8	11 fps	2 out of 4 V-sub-sampling
	6#	960 x 540	Mono8	32 fps	2x H+V sub-sampling
			Mono12	32 fps	2x H+V sub-sampling
			Mono16	31 fps	2x H+V sub-sampling
		960 x 540	YUV411	32 fps	2 out of 4 H+V sub-sampling
			YUV422,Raw16	31 fps	2 out of 4 H+V sub-sampling
			Mono8,Raw8	32 fps	2 out of 4 H+V sub-sampling
			RGB8	21 fps	2 out of 4 H+V sub-sampling

Table 89: Video Format_7 default modes PIKE F-210B / F-210C

#: Vertical sub-sampling is done via concealing certain lines, so the frame rate is not

frame rate = f (AOI height)
but
frame rate = f (2 x AOI height)

PIKE F-421B / PIKE F-421C

Format	Mode	Resolution	Color Mode	240 fps	120 fps	60 fps	30 fps	15 fps	7.5 fps	3.75 fps	1.875 fps
0	0	160 x 120	YUV444								
	1	320 x 240	YUV422				x	x	x	x	x
	2	640 x 480	YUV411				x	x	x	x	x
	3	640 x 480	YUV422				x	x	x	x	x
	4	640 x 480	RGB8				x	x	x	x	x
	5	640 x 480	Mono8				x x	x x*	x x*	x x*	x x*
	6	640 x 480	Mono16				x	x	x	x	x
1	0	800 x 600	YUV422				x	x	x	x	
	1	800 x 600	RGB8				x	x	x		
	2	800 x 600	Mono8				x x*	x x*	x x*		
	3	1024 x 768	YUV422				x	x	x	x	x
	4	1024 x 768	RGB8					x	x	x	x
	5	1024 x 768	Mono8				x x*	x x*	x x*	x x*	x x*
	6	800 x 600	Mono16				x	x	x	x	
	7	1024 x 768	Mono16				x	x	x	x	x
2	0	1280 x 960	YUV422					x	x	x	x
	1	1280 x 960	RGB8					x	x	x	x
	2	1280 x 960	Mono8					x x*	x x*	x x*	x x*
	3	1600 x 1200	YUV422					x	x	x	x
	4	1600 x 1200	RGB8						x	x	x
	5	1600 x 1200	Mono8					x x*	x x*	x x*	x x*
	6	1280 x 960	Mono16					x	x	x	x
	7	1600 x 1200	Mono16					x	x	x	x

Table 90: Video fixed formats PIKE F-421-B / PIKE F-421C

*: Color camera outputs RAW image, which needs to be converted outside of camera.

Frame rates with shading are only achievable with 1394b (S800).

Format	Mode	Resolution	Color Mode	Maximal S800 frame rates for Format_7 modes	
7	0	2048 x 2048	Mono8	16 fps	
			Mono12	10 fps	
			Mono16	8 fps	
		2048 x 2048	YUV411	10 fps	
			YUV422,Raw16	8 fps	
			Mono8,Raw8	16 fps	
			RGB8	5 fps	
	1	1024 x 2048	Mono8	16 fps	2x H-binning
			Mono12	16 fps	2x H-binning
			Mono16	16 fps	2x H-binning
	2	2048 x 1024	Mono8	29 fps	2x V-binning
			Mono12	21 fps	2x V-binning
			Mono16	16 fps	2x V-binning
	3	1024 x 1024	Mono8	29 fps	2x H+V binning
			Mono12	29 fps	2x H+V binning
			Mono16	29 fps	2x H+V binning
	4	1024 x 2048	Mono8	16 fps	2x H-sub-sampling
			Mono12	16 fps	2x H-sub-sampling
			Mono16	16 fps	2x H-sub-sampling
		1024 x 2048	YUV411	16 fps	2 out of 4 H-sub-sampling
			YUV422,Raw16	16 fps	2 out of 4 H-sub-sampling
			Mono8,Raw8	16 fps	2 out of 4 H-sub-sampling
			RGB8	10 fps	2 out of 4 H-sub-sampling
	5	2048 x 1024	Mono8	29 fps	2 out of 4 V-sub-sampling
			Mono12	21 fps	2 out of 4 V-sub-sampling
			Mono16	16 fps	2 out of 4 V-sub-sampling
		2048 x 1024	YUV411	29 fps	2 out of 4 V-sub-sampling
			YUV422,Raw16	21 fps	2 out of 4 V-sub-sampling
			Mono8,Raw8	29 fps	2 out of 4 V-sub-sampling
			RGB8	10 fps	2 out of 4 V-sub-sampling
	6	1024 x 1024	Mono8	29 fps	2 out of 4 H+V-sub-sampling
			Mono12	29 fps	2 out of 4 H+V-sub-sampling
			Mono16	29 fps	2 out of 4 H+V-sub-sampling
		1024 x 1024	YUV411	29 fps	2 out of 4 H+V-sub-sampling
			YUV422,Raw16	29 fps	2 out of 4 H+V-sub-sampling
			Mono8,Raw8	29 fps	2 out of 4 H+V-sub-sampling
			RGB8	21 fps	2 out of 4 H+V-sub-sampling

Table 91: Video Format_7 default modes PIKE F-421-B / PIKE F-421C

PIKE F-505B / PIKE F-505C

Format	Mode	Resolution	Color mode	240 fps	120 fps	60 fps	30 fps	15 fps	7.5 fps	3.75 fps	1.875 fps
0	0	160 x 120	YUV444								
	1	320 x 240	YUV422				x	x	x	x	x
	2	640 x 480	YUV411				x	x	x	x	x
	3	640 x 480	YUV422				x	x	x	x	x
	4	640 x 480	RGB8				x	x	x	x	x
	5	640 x 480	Mono8				x x*	x x*	x x*	x x*	x x*
	6	640 x 480	Mono16				x	x	x	x	x
1	0	800 x 600	YUV422					x	x	x	
	1	800 x 600	RGB8					x	x		
	2	800 x 600	Mono8					x x*	x x*		
	3	1024 x 768	YUV422					x	x	x	x
	4	1024 x 768	RGB8					x	x	x	x
	5	1024 x 768	Mono8					x x*	x x*	x x*	x x*
	6	800 x 600	Mono16					x	x	x	
	7	1024 x 768	Mono16					x	x	x	x
2	0	1280 x 960	YUV422					x	x	x	x
	1	1280 x 960	RGB8					x	x	x	x
	2	1280 x 960	Mono 8					x x*	x x*	x x*	x x*
	3	1600 x 1200	YUV422					x	x	x	x
	4	1600 x 1200	RGB8						x	x	x
	5	1600 x 1200	Mono8					x x*	x x*	x x*	x x*
	6	1280 x 960	Mono16					x	x	x	x
	7	1600 x 1200	Mono16					x	x	x	x

Table 92: Video fixed formats PIKE F-505B / F-505C

*: Color camera outputs RAW image, which needs to be converted outside of camera.

Frame rates with shading are only achievable with 1394b (S800).

Format	Mode	Resolution	Color mode	Maximal S800 frame rates for Format_7 modes	
7	0	2452 x 2054	Mono8	13 fps	
			Mono12	09 fps	
			Mono16	07 fps	
		2452 x 2054	YUV411	09 fps	
			YUV422,Raw16	07 fps	
			Mono8,Raw8	13 fps	
			RGB8	04 fps	
			Raw12	09 fps	
	1	1224 x 2054	Mono8	15 fps	2x H-binning
			Mono12	15 fps	2x H-binning
			Mono16	13 fps	2x H-binning
	2	2452 x 1026	Mono8	22 fps	2x V-binning
			Mono12	17 fps	2x V-binning
			Mono16	13 fps	2x V-binning
	3	1224 x 1026	Mono8	22 fps	2x H+V binning
			Mono12	22 fps	2x H+V binning
			Mono16	22 fps	2x H+V binning
	4	1224 x 2054	Mono8	15 fps	2 out of 4 H-sub-sampling
			Mono12	15 fps	2 out of 4 H-sub-sampling
			Mono16	13 fps	2 out of 4 H-sub-sampling
		1224 x 2054	YUV411	15 fps	2 out of 4 H-sub-sampling
			YUV422,Raw16	13 fps	2 out of 4 H-sub-sampling
			Mono8,Raw8	15 fps	2 out of 4 H-sub-sampling
			RGB8	09 fps	2 out of 4 H-sub-sampling
			Raw12	15 fps	2 out of 4 H-sub-sampling
	5	2452 x 1026	Mono8	22 fps	2 out of 4 V-sub-sampling
			Mono12	17 fps	2 out of 4 V-sub-sampling
			Mono16	13 fps	2 out of 4 V-sub-sampling
		2452 x 1026	YUV411	17 fps	2 out of 4 V-sub-sampling
			YUV422,Raw16	13 fps	2 out of 4 V-sub-sampling
			Mono8,Raw8	22 fps	2 out of 4 V-sub-sampling
			RGB8	09 fps	2 out of 4 V-sub-sampling
			Raw12	17 fps	2 out of 4 V-sub-sampling
	6	1224 x 1026	Mono8	22 fps	2 out of 4 H+V-sub-sampling
			Mono12	22 fps	2 out of 4 H+V-sub-sampling
			Mono16	22 fps	2 out of 4 H+V-sub-sampling
		1224 x 1026	YUV411	22 fps	2 out of 4 H+V-sub-sampling
			YUV422,Raw16	22 fps	2 out of 4 H+V-sub-sampling
			Mono8,Raw8	22 fps	2 out of 4 H+V-sub-sampling
			RGB8	17 fps	2 out of 4 H+V-sub-sampling
			Raw12	22 fps	2 out of 4 H+V-sub-sampling

Table 93: Video Format_7 default modes PIKE F-505B / F-505C

Area of interest (AOI)

The camera’s image sensor has a defined resolution. This indicates the maximum number of lines and pixels per line that the recorded image may have.

However, often only a certain section of the entire image is of interest. The amount of data to be transferred can be decreased by limiting the image to a section when reading it out from the camera. At a lower vertical resolution the sensor can be read out faster and thus the frame rate is increased.

Note

The setting of AOIs is supported only in video Format_7.

While the size of the image read out for most other video formats and modes is fixed by the IIDC specification, thereby determining the highest possible frame rate, in Format_7 mode the user can set the **upper left corner** and **width and height** of the section (area of interest = AOI) he is interested in to determine the size and thus the highest possible frame rate.

Setting the AOI is done in the IMAGE_POSITION and IMAGE_SIZE registers.

Attention should be paid to the increments entered in the UNIT_SIZE_INQ and UNIT_POSITION_INQ registers when configuring IMAGE_POSITION and IMAGE_SIZE.

AF_AREA_POSITION and AF_AREA_SIZE contain in the respective bits values for the column and line of the upper left corner and values for the width and height.

Note

For more information see Table 132: Format_7 control and status register on page 276.

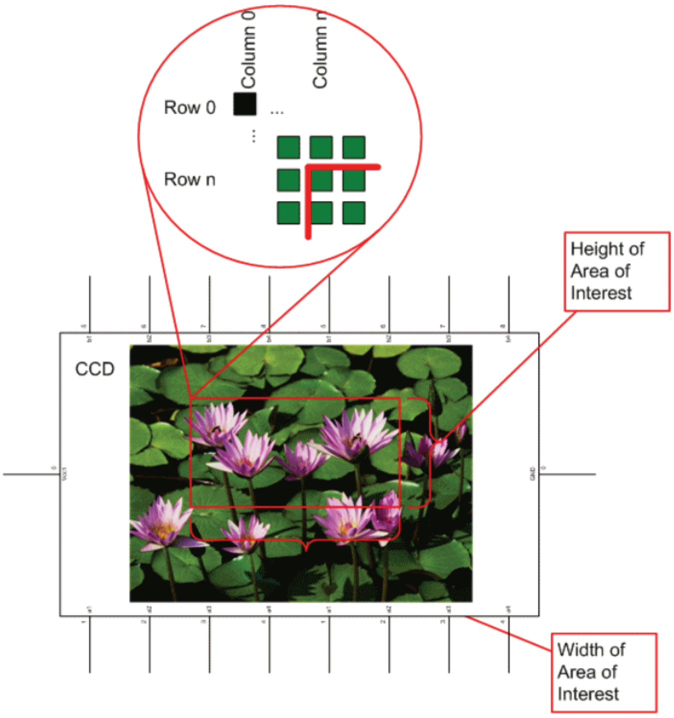


Figure 101: Area of interest (AOI)

Note

- The left position + width and the upper position + height may not exceed the maximum resolution of the sensor.
- The coordinates for width and height must be divisible by 4.

In addition to the AOI, some other parameters have an effect on the maximum frame rate:

- the time for reading the image from the sensor and transporting it into the FRAME_BUFFER
- the time for transferring the image over the FireWire™ bus
- the length of the exposure time.

Autofunction AOI

Use this feature to select the image area (work area) on which the following autofunctions work:

- auto shutter
- auto gain
- auto white balance

In the following screenshot you can see an example of the autofunction AOI:

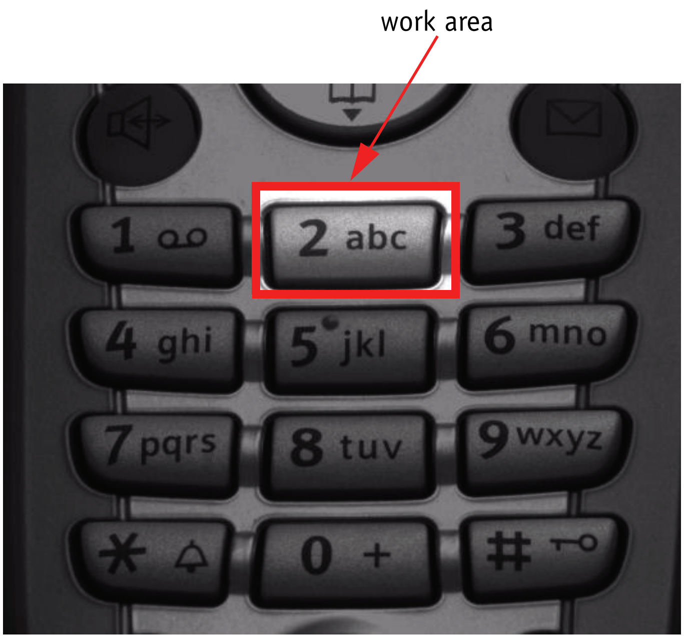


Figure 102: Example of autofunction AOI (Show work area is on)

Note

For more information see Chapter Autofunction AOI on page 301.

Frame rates

An IEEE 1394 camera requires bandwidth to transport images.

The IEEE 1394b bus has very large bandwidth of at least 62.5 MByte/s for transferring (isochronously) image data. Per cycle up to 8192 bytes (or around 2000 quadlets = 4 bytes@ 800 Mbit/s) can thus be transmitted.

Note

All bandwidth data is calculated with:

1 MByte = 1024 kByte

Depending on the video format settings and the configured frame rate, the camera requires a certain percentage of maximum available bandwidth. Clearly the bigger the image and the higher the frame rate, the more data is to be transmitted.

The following tables indicate the volume of data in various formats and modes to be sent within one cycle (125 µs) at 800 Mbit/s of bandwidth.

The tables are divided into three formats:

Format	Resolution	max. Video Format
Format_0	up to VGA	640 x 480
Format_1	up to XGA	1024 x 768
Format_2	up to UXGA	1600 x 1200

Table 94: Overview fixed formats

They enable you to calculate the required bandwidth and to ascertain the number of cameras that can be operated independently on a bus and in which mode.

Format	Mode	Resolution	240 fps	120 fps	60 fps	30 fps	15 fps	7.5 fps	3.75 fps
0	0	160 x 120 YUV (4:4:4) 24 bit/pixel	4H 640p 480q	2H 320p 240q	1H 160p 120q	1/2H 80p 60q	1/4H 40p 30q	1/8H 20p 15q	
	1	320 x 240 YUV (4:2:2) 16 bit/pixel	8H 2560p 1280q	4H 1280p 640q	2H 640p 320q	1H 320p 160q	1/2H 160p 80q	1/4H 80p 40q	1/8H 40p 20q
	2	640 x 480 YUV (4:1:1) 12 bit/pixel		8H 5120p 1920q	4H 2560p 960q	2H 1280p 480q	1H 640p 240q	1/2H 320p 120q	1/4H 160p 60q
	3	640 x 480 YUV (4:2:2) 16 bit/pixel			4H 2560p 1280q	2H 1280p 640q	1H 640p 320q	1/2H 320p 160q	1/4H 160p 80q
	4	640 x 480 RGB 24 bit/pixel			4H 2560p 1280q	2H 1280p 960q	1H 640p 480q	1/2H 320p 240q	1/4H 160p 120q
	5	640 x 480 (Mono8) 8 bit/pixel		8H 5120p 1280q	4H 2560p 640q	2H 1280p 320q	1H 640p 160q	1/2H 320p 80q	1/4H 160 p40q
	6	640 x 480 Y (Mono16) 16 Bit/pixel			4H 2560p 1280q	2H 1280p 640q	1H 640p 320q	1/2H 320p 160q	1/4H 160p 80q
	7	Reserved							

Table 95: Format_0

As an example, VGA Mono8 @ 60 fps requires four lines (640 x 4 = 2560 pixels/byte) to transmit every 125 µs: this is a consequence of the sensor's line time of about 30 µs, so that no data needs to be stored temporarily. It takes 120 cycles (120 x 125 µs = 15 ms) to transmit one frame, which arrives every 16.6 ms from the camera. Again no data need to be stored temporarily.

Thus around 64% of the available bandwidth (at S400) is used. Thus one camera can be connected to the bus at S400.

The same camera, run at S800 would require only 32% of the available bandwidth, due to the doubled speed. Thus up to three cameras can be connected to the bus at S800.

Format	Mode	Resolution	240 fps	120 fps	60 fps	30 fps	15 fps	7.5 fps	3.75 fps	1.875 fps
1	0	800 x 600 YUV (4:2:2) 16 bit/pixel			5H 4000p 2000q	5/2H 2000p 1000q	5/4H 1000p 500q	5/8H 500p 250q	6/16H 250p 125q	
	1	800 x 600 RGB 24 bit/pixel				5/2H 2000p 1500q	5/4H 1000p 750q	5/8H 500p 375q		
	2	800 x 600 Y (Mono8) 8 bit/pixel		10H 8000p 2000q	5H 4000p 1000q	5/2H 2000p 500q	5/4H 1000p 250q	5/8H 500p 125q		
	3	1024 x 768 YUV (4:2:2) 16 bit/pixel				3H 3072p 1536q	3/2H 1536p 768q	3/4H 768p 384q	3/8H 384p 192q	3/16H 192p 96q
	4	1024 x 768 RGB 24 bit/pixel					3/2H 1536p 384q	3/4H 768p 576q	3/8H 384p 288q	3/16H 192p 144q
	5	1024 x 768 Y (Mono) 8 bit/pixel			6H 6144p 1536q	3H 3072p 768q	3/2H 1536p 384q	3/4H 768p 192q	3/8H 384p 96q	3/16H 192p 48q
	6	800 x 600 (Mono16) 16 bit/pixel			5H 4000p 2000q	5/2H 2000p 1000q	5/4H 1000p 500q	5/8H 500p 250q	5/16H 250p 125q	
	7	1024 x 768 Y (Mono16) 16 bit/pixel				3H 3072p 1536q	3/2H 1536p 768q	3/4H 768p 384q	3/8H 384p 192q	3/16H 192p 96q

Table 96: Format_1

Format	Mode	Resolution	60 fps	30 fps	15 fps	7.5 fps	3.75 fps	1.875 fps
2	0	1280 x 960 YUV (4:2:2) 16 bit/pixel			2H 2560p 1280q	1H 1280p 640q	1/2H 640p 320q	1/4H 320p 160q
	1	1280 x 960 RGB 24 bit/pixel			2H 2560p 1920q	1H 1280p 960q	1/2H 640p 480q	1/4H 320p 240q
	2	1280 x 960 Y (Mono8) 8 bit/pixel		4H 5120p 1280q	2H 2560p 640q	1H 1280p 320q	1/2H 640p 160q	1/4H 320p 80q
	3	1600 x 1200 YUV(4:2:2) 16 bit/pixel			5/2H 4000p 2000q	5/4H 2000p 1000q	5/8H 1000p 500q	5/16H 500p 250q
	4	1600 x 1200 RGB 24 bit/pixel				5/4H 2000p 1500q	5/8H 1000p 750q	5/16 500p 375q
	5	1600 x 1200 Y (Mono) 8 bit/pixel		5H 8000p 2000q	5/2H 4000p 1000q	5/4H 2000p 500q	5/8H 1000p 250q	5/16H 500p 125q
	6	1280 x 960 Y (Mono16) 16 bit/pixel			2H 2560p 1280q	1H 1280p 640q	1/2H 640p 320q	1/4H 320p 160q
	7	1600 x 1200Y(Mono16) 16 bit/pixel			5/2H 4000p 2000q	5/4H 2000p 1000q	5/8H 1000p 500q	5/16H 500p 250q

Table 97: Format_2

As already mentioned, the recommended limit for transferring isochronous image data is 2000q (quadlets) per cycle or 8192 bytes (with 800 Mbit/s of bandwidth).

Note

- If the cameras are operated with an external trigger the maximum trigger frequency may not exceed the highest continuous frame rate, so preventing frames from being dropped or corrupted.
- IEEE 1394 adapter cards with PCILynx™ chipsets (predeccessor of OHCI) have a limit of 4000 bytes per cycle.

The frame rates in video modes 0 to 2 are specified and set fixed by IIDC V1.31.

Frame rates Format_7

In video Format_7 frame rates are no longer fixed.

For the different sensors, different values apply.

Frame rates may be further limited by bandwidth limitation from the IEEE 1394 bus.

Details are described in the next chapters:

- Max. frame rate of CCD (theoretical formula)
- Diagram of frame rates as function of AOI by const. width: the curves describe RAW8, RAW12/YUV411, RAW16/YUV422, RGB8 and max. frame rate of CCD
- Table with max. frame rates as function of AOI by const. width

PIKE F-032: AOI frame rates

$$\text{max. frame rate of CCD} = \frac{1}{69.3\mu s + \text{AOI height} \times 9.81\mu s + (490 - \text{AOI height}) \times 0.81\mu s}$$

Formula 3: **PIKE F-032**: theoretical max. frame rate of CCD

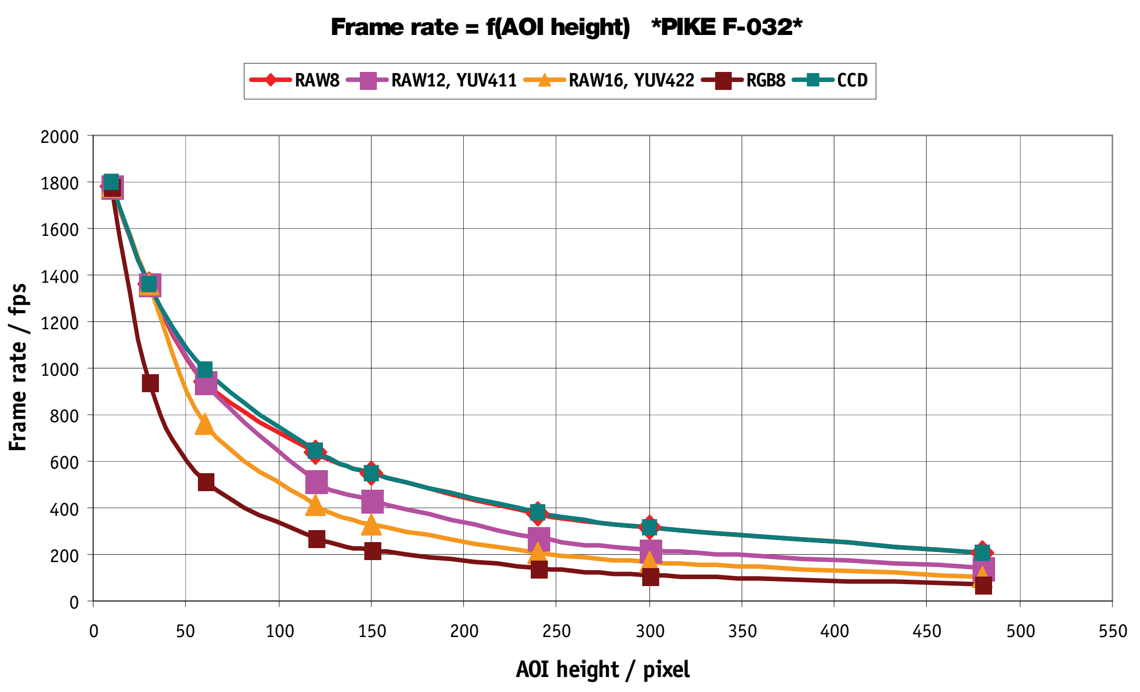


Figure 103: Frame rates **PIKE F-032** as function of AOI height [**width=640**]

AOI height	CCD	Raw8	Raw12	Raw16	YUV411	YUV422	RGB8
480	208.93	208	139	105	139	105	70
300	315.84	314	219	168	219	168	112
240	380.78	372	271	208	271	208	139
150	550.60	551	432	327	432	327	219
120	646.75	640	516	410	516	410	271
60	993.84	941	941	762	941	762	516
30	1358.33	1358	1358	1358	1358	1358	941
10	1797.91	1778	1778	1778	1778	1778	1778

Table 98: Frame rates (fps) of **PIKE F-032** as function of AOI height (pixel) [**width=640**]

Note

CCD = theoretical max. frame rate (in fps) of CCD according to given formula

PIKE F-100: AOI frame rates

$$\text{max. frame rate of CCD} = \frac{1}{174\mu s + \text{AOI height} \times 16.40\mu s + (1008 - \text{AOI height}) \times 3.4\mu s}$$

Formula 4: **Pike F-100**: theoretical max. frame rate of CCD

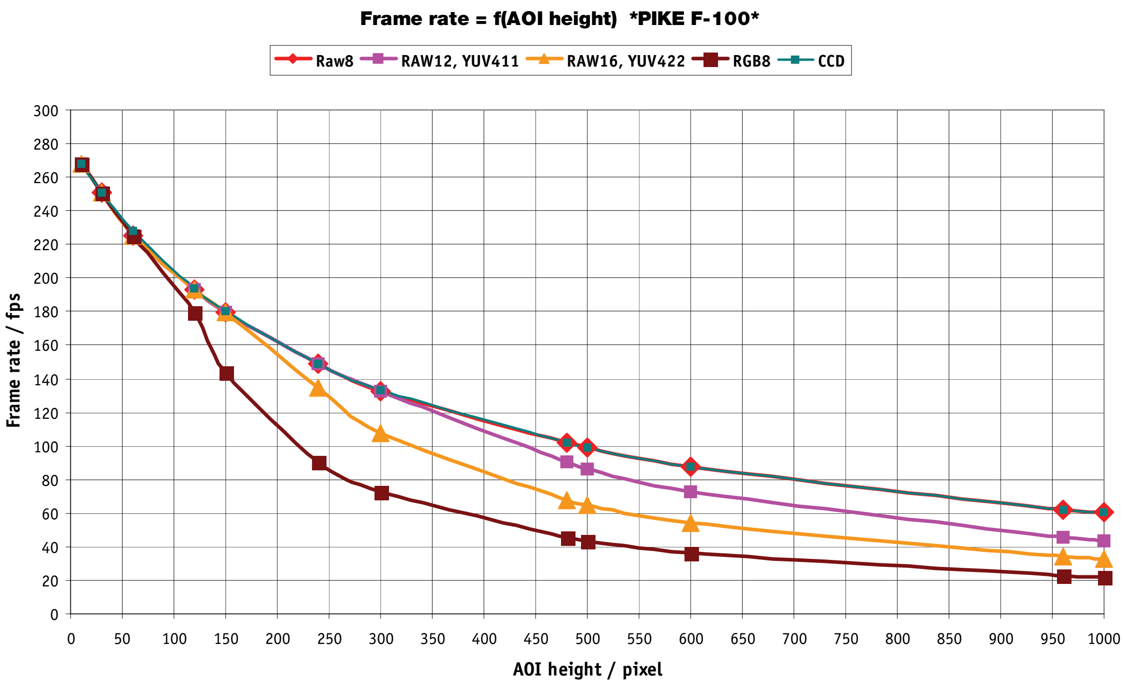


Figure 104: Frame rates **PIKE F-100** as function of AOI height [**width=1000**]

AOI height	CCD	RAW8	RAW12	RAW16	YUV411	YUV422	RGB8
1000	60.24	60	43	33	43	33	22
960	62.18	62	45	34	45	34	23
600	87.71	87	72	54	72	54	36
500	99.00	99	86	65	86	65	43
480	101.61	102	90	68	90	68	45

Table 99: Frame rates (fps) of **PIKE F-100** as function of AOI height (pixel) [**width=1000**]

AOI height	CCD	RAW8	RAW12	RAW16	YUV411	YUV422	RGB8
300	133.31	132	132	107	132	107	72
240	148.78	149	149	134	149	134	90
150	180.14	180	180	180	180	180	144
120	193.75	193	193	193	193	193	180
60	228.25	225	225	225	225	225	225
30	250.55	251	251	251	251	251	251
10	268.01	268	268	268	268	268	268

Table 99: Frame rates (fps) of **PIKE F-100** as function of AOI height (pixel) [**width=1000**]

Note

CCD = theoretical max. frame rate (in fps) of CCD according to given formula

PIKE F-145: AOI frame rates (no sub-sampling)

$$\text{max. frame rate of CCD} = \frac{1}{242\mu s + \text{AOI height} \times 31.80\mu s + (1051 - \text{AOI height}) \times 5.85\mu s}$$

Formula 5: **Pike F-145**: theoretical max. frame rate of CCD (**no sub-sampling**)

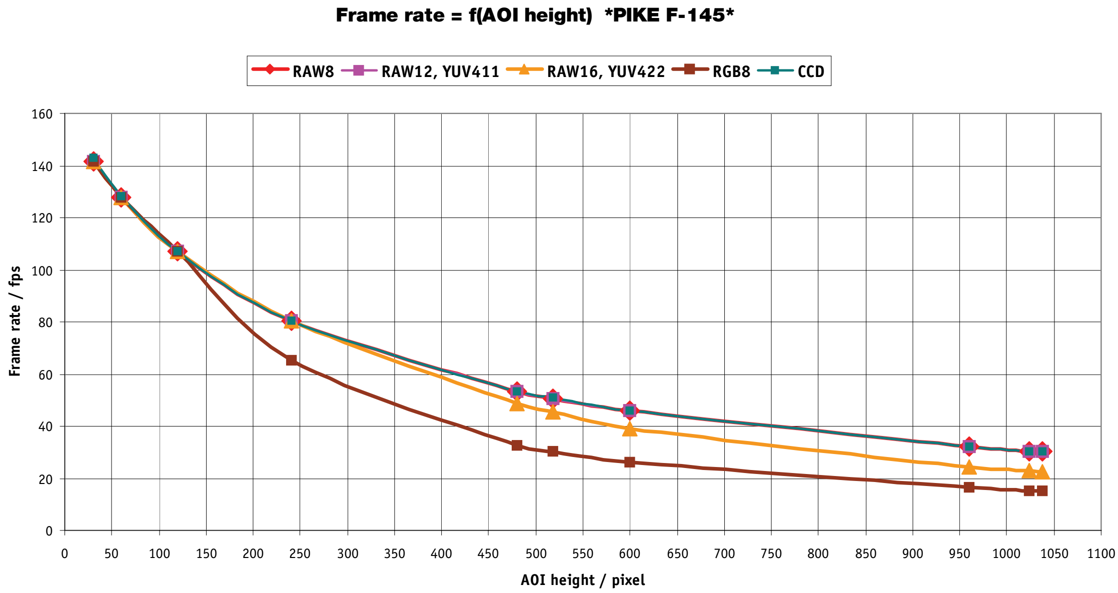


Figure 105: Frame rates **PIKE F-145** as function of AOI height [**width=1388**]

AOI height	CCD	RAW8	RAW12	RAW16	YUV411	YUV422	RGB8
1038	30.01	30	30	23	30	23	15
1024	30.34	30	30	23	30	23	15
960	31.95	32	32	25	32	25	16
600	45.54	46	46	39	46	39	26
518	50.42	50	50	45	50	45	30
480	53.06	53	53	49	53	49	33
240	79.25	79	79	79	79	79	65
120	105.21	105	105	105	105	105	105
60	125.83	126	126	126	126	126	126
30	139.49	139	139	139	139	139	139

Table 100: Frame rates (fps) of **PIKE F-145** as function of AOI height (pixel) [**width=1388**]

Note

CCD = theoretical max. frame rate (in fps) of CCD according to given formula

PIKE F-145: AOI frame rates (sub-sampling)

$$\text{max. frame rate of CCD} = \frac{1}{242\mu s + \text{AOI height} \times 1.5 \times 31.80\mu s + (1051 - \text{AOI height} \times 1.5) \times 5.85\mu s}$$

Formula 6: **Pike F-145**: theoretical max. frame rate of CCD (**sub-sampling**)

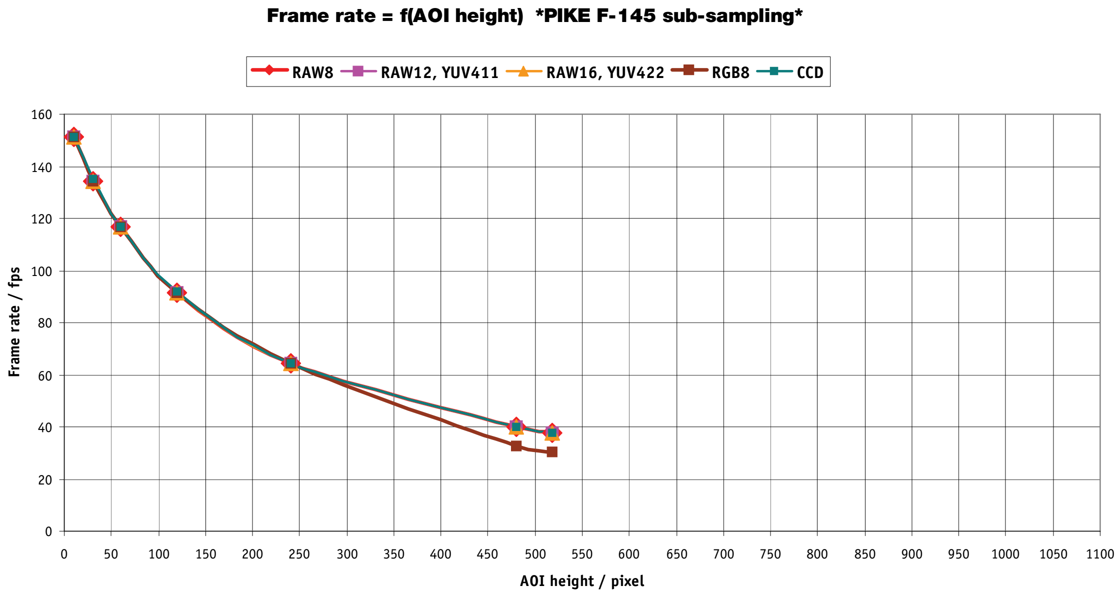


Figure 106: Frame rates **PIKE F-145** as function of AOI height [**width=1388**] (**sub-sampling**)

AOI height	CCD	RAW8	RAW12	RAW16	YUV411	YUV422	RGB8
518	37.66	38	38	38	38	38	30
480	39.88	40	40	40	40	40	33
240	63.56	64	64	64	64	64	64
120	90.40	90	90	90	90	90	90
60	114.60	115	115	115	115	115	115
30	132.31	132	132	132	132	132	132
10	147.50	147	147	147	147	147	147

Table 101: Frame rates (fps) **PIKE F-145** as function of AOI height (pixel) [**width=1388**] (**sub-sampl.**)

Note

CCD = theoretical max. frame rate (in fps) of CCD according to given formula

PIKE F-145-15fps: AOI frame rates (no sub-sampl.)

$$\text{max. frame rate of CCD} = \frac{1}{450\mu s + \text{AOI height} \times 59.36\mu s + (1051 - \text{AOI height}) \times 10.92\mu s}$$

Formula 7: **Pike F-145-15fps**: theoretical max. frame rate of CCD (**no sub-sampling**)

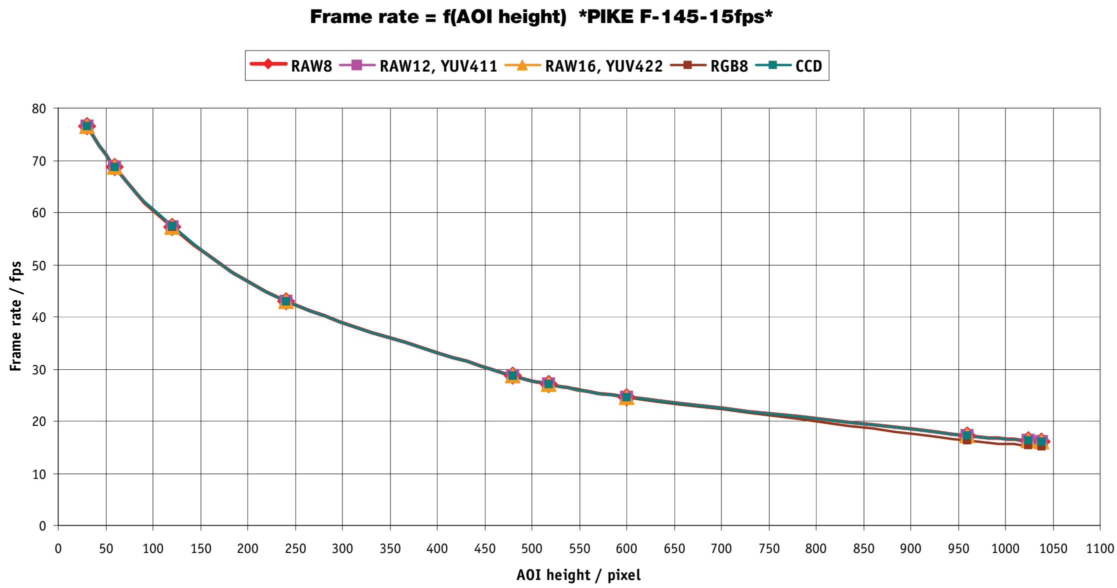


Figure 107: Frame rates **PIKE F-145-15fps** as function of AOI height [**width=1388**]

AOI height	CCD	RAW8	RAW12	RAW16	YUV411	YUV422	RGB8
1038	16.08	16	16	16	16	16	15
1024	16.25	16	16	16	16	16	15
960	17.11	17	17	17	17	17	16
600	24.40	24	24	24	24	24	24
518	27.01	27	27	27	27	27	27
480	28.43	28	28	28	28	28	28
240	42.46	42	42	42	42	42	42
120	56.37	56	56	56	56	56	56
60	67.42	67	67	67	67	67	67
30	74.74	74	74	74	74	74	74

Table 102: Frame rates (fps) of **PIKE F-145-15fps** as function of AOI height (pixel) [**width=1388**]

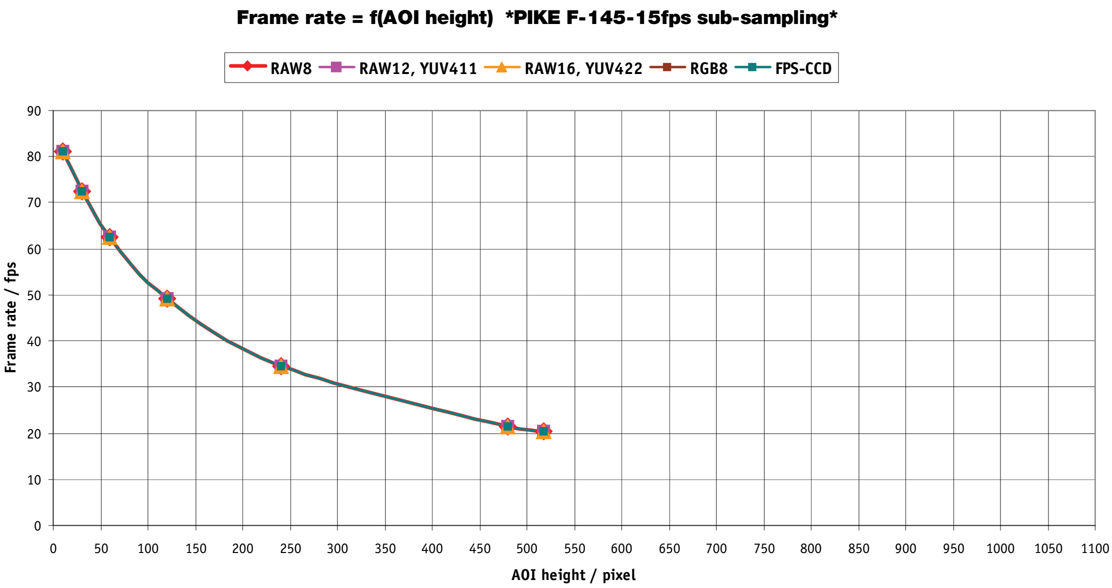
Note

CCD = theoretical max. frame rate (in fps) of CCD according to given formula

PIKE F-145-15fps: AOI frame rates (sub-sampl.)

$$\text{max. frame rate of CCD} = \frac{1}{450\mu s + \text{AOI height} \times 1.5 \times 59.36\mu s + (1051 - \text{AOI height} \times 1.5) \times 10.92\mu s}$$

Formula 8: **Pike F-145-15fps**: theoretical max. frame rate of CCD (**sub-sampling**)



Formula 9: Frame rates **PIKE F-145-15fps** as function of AOI height [**width=1388**] (**sub-sampling**)

AOI height	CCD	RAW8	RAW12	RAW16	YUV411	YUV422	RGB8
518	20.18	20	20	20	20	20	20
480	21.37	21	21	21	21	21	21
240	34.05	34	34	34	34	34	34
120	48.44	48	48	48	48	48	48
60	61.40	61	61	61	61	61	61
30	70.89	71	71	71	71	71	71
10	79.03	79	79	79	79	79	79

Table 103: Frame rates of **PIKE F-145-15fps** as function of AOI height [**width=1388**] (**sub-sampl.**)

Note

CCD = theoretical max. frame rate (in fps) of CCD according to given formula

PIKE F-210: AOI frame rates (no sub-sampling)

$$\text{max. frame rate of CCD} = \frac{1}{107\mu s + \text{AOI height} \times 28.6\mu s + (1092 - \text{AOI height}) \times 6.75\mu s}$$

Formula 10: **Pike F-210**: theoretical max. frame rate of CCD (**no sub-sampling**)

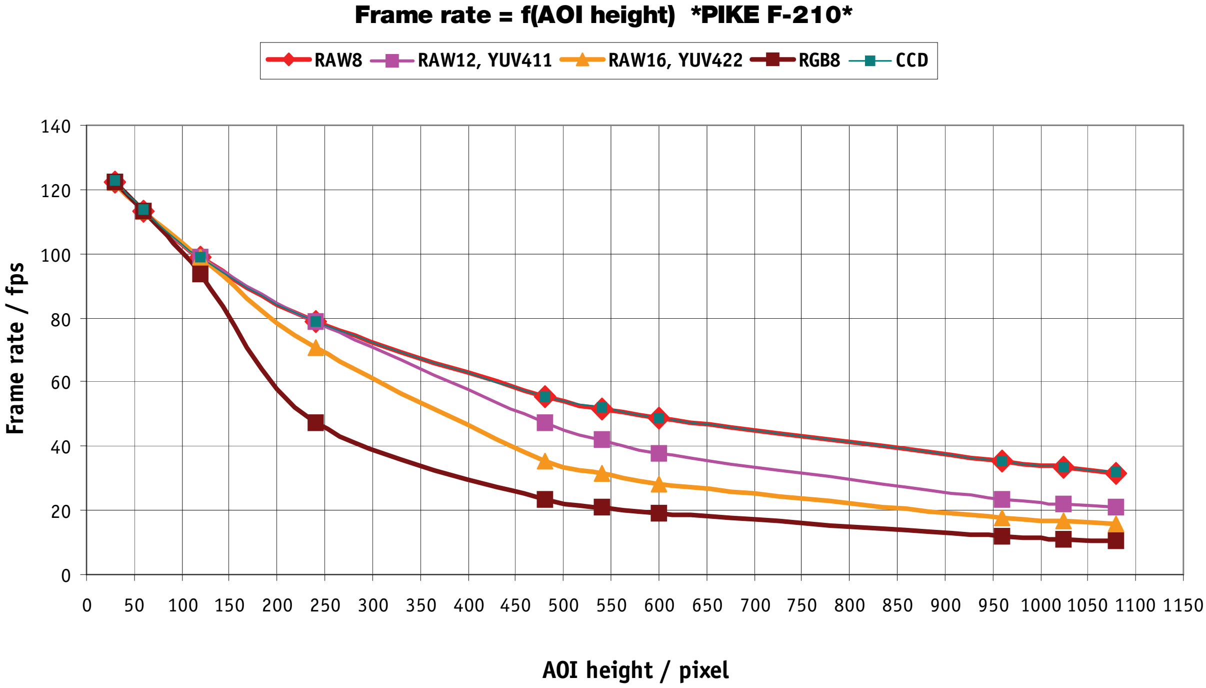


Table 104: Frame rates **PIKE F210** as function of AOI height [**width=1000**] (**no sub-sampling**)

AOI height	CCD	RAW8	RAW12	RAW16	YUV411	YUV422	RGB8
1080	32.18	31	21	16	21	16	11
1024	33.50	33	22	17	22	17	11
960	35.14	35	24	18	24	18	12
600	48.57	49	38	28	38	28	19
540	51.88	52	42	31	42	31	21
480	55.66	56	47	35	47	35	24
240	78.60	79	79	70	79	70	47
120	99.01	99	99	99	99	99	94

Table 105: Frame rates of **PIKE F-210** as function of AOI height [**width=1000**] (**no sub-sampl.**)

AOI height	CCD	RAW8	RAW12	RAW16	YUV411	YUV422	RGB8
60	113.78	113	113	113	113	113	113
30	122.95	122	122	122	122	122	122

Table 105: Frame rates of **PIKE F-210** as function of AOI height [**width=1000**] (**no sub-sampl.**)

Note

CCD = theoretical max. frame rate (in fps) of CCD according to given formula

Note

In Format_7 Mode_5 and Mode_6 the **Pike F-210** has a frame rate of:

frame rate ~ f(2 x AOI height)

PIKE F-210: AOI frame rates (sub-sampling)

$$\text{max. frame rate of CCD} = \frac{1}{107\mu s + \text{AOI height} \times 1.5 \times 28.6\mu s + (1092 - \text{AOI height} \times 1.5) \times 6.75\mu}$$

Formula 11: **Pike F-210**: theoretical max. frame rate of CCD (**sub-sampling**)

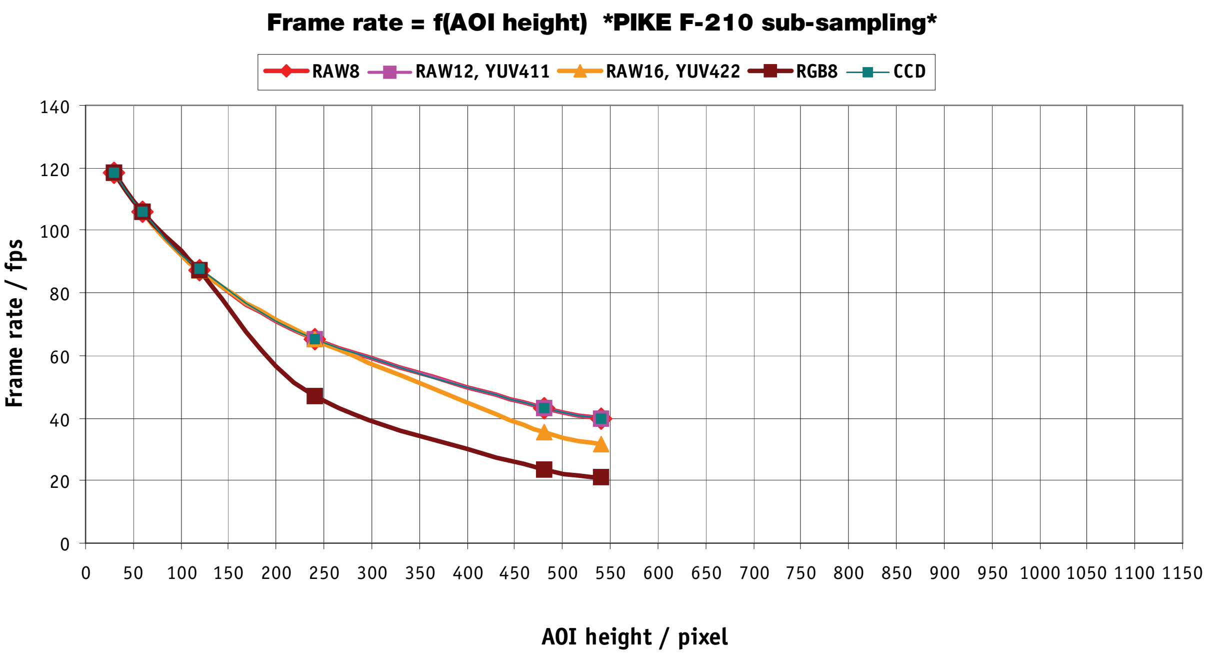


Table 106: Frame rates **PIKE F210** as function of AOI height [**width=1000**] (**sub-sampling**)

AOI height	CCD	RAW8	RAW12	RAW16	YUV411	YUV422	RGB8
540	39.72	40	40	31	40	31	21
480	43.08	43	43	35	43	35	24
240	65.17	65	65	65	65	65	47
120	87.63	87	87	87	87	87	87
60	105.88	106	106	106	106	106	106
30	118.19	118	118	118	118	118	118

Table 107: Frame rates (fps) of **PIKE F-210** as function of AOI height [**width=1000**] (**sub-sampling**)

Note

CCD = theoretical max. frame rate (in fps) of CCD according to given formula

In Format_7 Mode_5 and Mode_6 the **Pike F-210** has a frame rate of:

frame rate ~ f(2 x AOI height)

PIKE F-421: AOI frame rates

$$\text{max. frame rate of CCD} = \frac{1}{125.2\mu s + \text{AOI height} \times 30.10\mu s + (2072 - \text{AOI height}) \times 3.37\mu s}$$

Formula 12: Pike F-421: theoretical max. frame rate of CCD

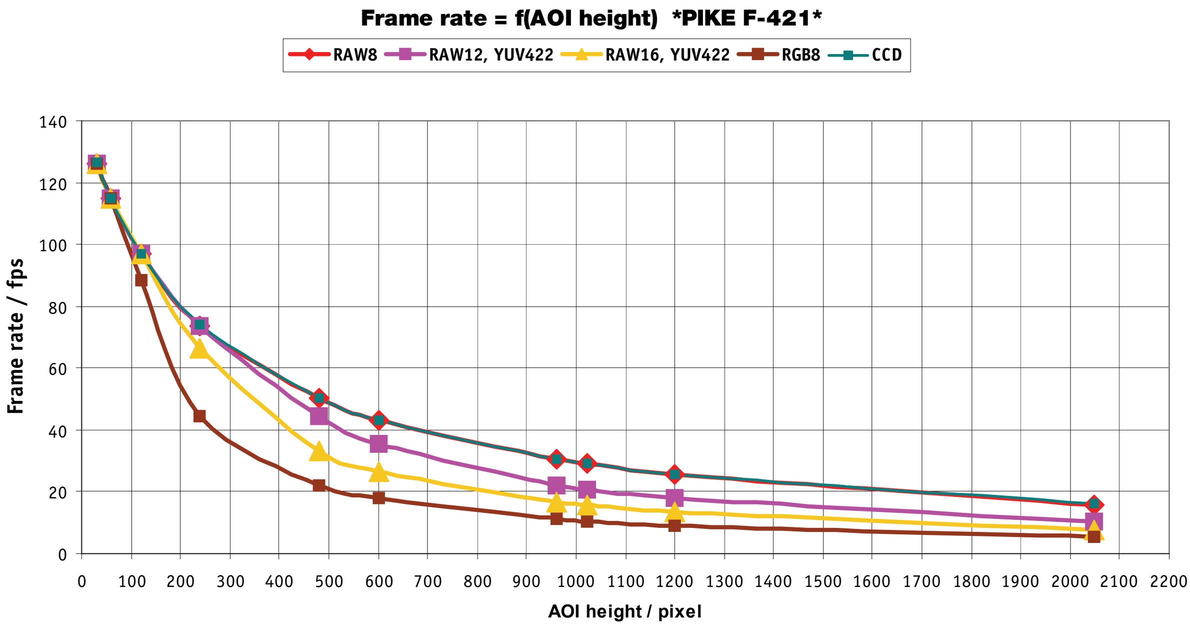


Table 108: Frame rates **PIKE F-421** as function of AOI height[**width=2048**]

AOI height	CCD	RAW8	RAW12	RAW16	YUV411	YUV422	RGB8
2048	16.17	16	10	8	10	8	5
1200	25.52	26	18	13	18	13	9
1024	29.00	29	21	16	21	16	10
960	30.52	30	22	17	22	17	11
600	43.20	43	35	27	35	27	18
480	50.15	50	44	33	44	33	22
240	73.95	74	74	66	74	66	44
120	96.94	97	97	97	97	97	88
60	114.79	115	115	115	115	115	115
30	126.43	126	126	126	126	126	126

Table 109: Frame rates **PIKE F-421** as function of AOI height [**width=2048**]

Note

CCD = theoretical max. frame rate (in fps) of CCD according to given formula

PIKE F-505: AOI frame rates

$$\text{max. frame rate of CCD} = \frac{1}{636\mu s + \text{AOI height} \times 33.10\mu s + (2069 - \text{AOI height}) \times 10.34\mu s}$$

Formula 13: **Pike F-505**: theoretical max. frame rate of CCD

AOI frame rates with max. BPP = 8192

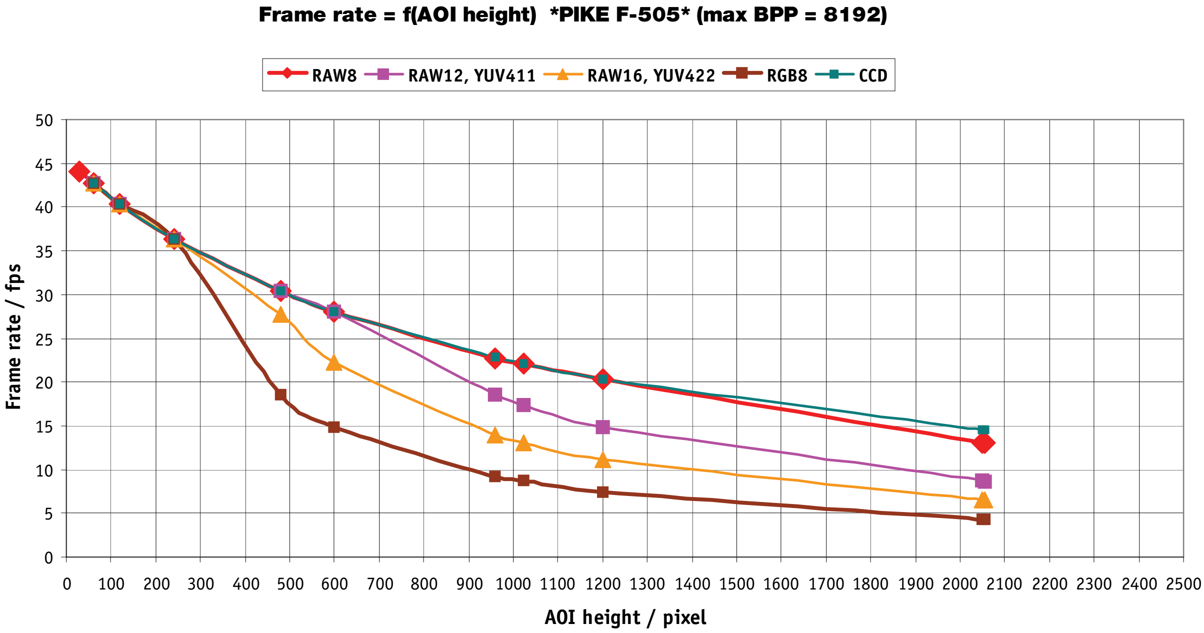


Figure 108: Frame rates **PIKE F-505** as function of AOI height [**width=2452**] (**max BPP = 8192**)

AOI height	CCD	RAW8	RAW12	RAW16	YUV411	YUV422	RGB8
2054	14.54	13	9	7	9	7	4
2048	14.57	13	9	7	9	7	4
1200	20.27	20	15	11	15	11	7
1024	22.06	22	17	13	17	13	9
960	22.79	23	18	14	18	14	9
600	28.02	28	28	22	28	22	15
480	30.35	30	30	28	30	28	18
240	36.37	36	36	36	36	36	36

Table 110: Frame rates **PIKE F-505** as function of AOI height (pixel) [**width=2452**] (**maxBPP=8192**)

AOI height	CCD	RAW8	RAW12	RAW16	YUV411	YUV422	RGB8
120	40.39	40	40	40	40	40	40
60	42.74	43	43	43	43	43	43
30	44.03	44	44	44	44	44	44

Table 110: Frame rates **PIKE F-505** as function of AOI height (pixel) [**width=2452**] (**maxBPP=8192**)

Note

CCD = theoretical max. frame rate (in fps) of CCD according to given formula

AOI frame rates with max. BPP = 11000

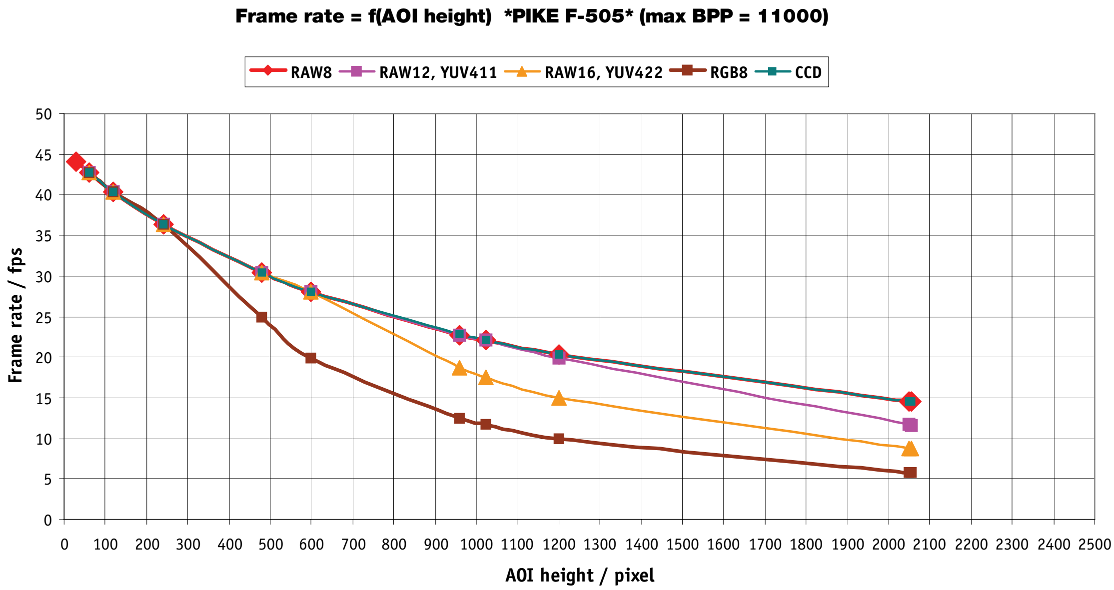


Figure 109: Frame rates **PIKE F-505** as function of AOI height [**width=2452**] (**max BPP = 11000**)

AOI height	CCD	RAW8	RAW12	RAW16	YUV411	YUV422	RGB8
2054	14.54	15	12	9	12	9	6
2048	14.57	15	12	9	12	9	6
1200	20.27	20	20	15	20	15	10
1024	22.06	22	22	17	22	17	12
960	22.79	23	23	19	23	19	12
600	28.02	28	28	28	28	28	20
480	30.35	30	30	30	30	30	25
240	36.37	36	36	36	36	36	36
120	40.39	40	40	40	40	40	40
60	42.74	43	43	43	43	43	43
30	44.03	44	44	44	44	44	44

Table 111: Frame rates **PIKE F-505** as function of AOI height [**width=2452**] (**maxBPP=11000**)

Note

CCD = theoretical max. frame rate (in fps) of CCD according to given formula

How does bandwidth affect the frame rate?

In some modes the IEEE 1394b bus limits the attainable frame rate. According to the 1394b specification on isochronous transfer, the largest data payload size of 8192 bytes per 125 µs cycle is possible with bandwidth of 800 Mbit/s. In addition, there is a limitation, only a maximum number of 65535 (2^{16} -1) packets per frame are allowed.

The following formula establishes the relationship between the required Byte_Per_Packet size and certain variables for the image. It is valid only for Format_7.

$$\text{BYTE\_PER\_PACKET} = \text{frame rate} \times \text{AOI\_WIDTH} \times \text{AOI\_HEIGHT} \times \text{ByteDepth} \times 125\mu s$$

Formula 14: Byte_per_Packet calculation (only Format_7)

If the value for **BYTE_PER_PACKET** is greater than 8192 (the maximum data payload), the sought-after frame rate cannot be attained. The attainable frame rate can be calculated using this formula:

(Provision: **BYTE_PER_PACKET** is divisible by 4):

$$\text{frame rate} \approx \frac{\text{BYTE\_PER\_PACKET}}{\text{AOI\_WIDTH} \times \text{AOI\_HEIGHT} \times \text{ByteDepth} \times 125\mu s}$$

Formula 15: Maximum frame rate calculation

ByteDepth based on the following values:

Mode	bit/pixel	byte per pixel
Mono8, Raw8	8	1
Mono16, Raw16	16	2
YUV4:2:2	16	2
YUV4:1:1	12	1.5
RGB8	24	3

Table 112: ByteDepth

Example formula for the b/w camera

Mono16, 1392 x 1040, 30 fps desired

$$\mathrm{BYTE\_PER\_PACKET} = 30 \times 1392 \times 1040 \times 2 \times 125\mu s = 10856 > 8192$$

$$\Rightarrow \quad \text{frame rate}_{\text{reachable}} \approx \frac{8192}{1392 \times 1040 \times 2 \times 125\mu s} = 22.64$$

Formula 16: Example maximum frame rate calculation

Test images

Loading test images

FirePackage	Direct FirePackage	Fire4Linux
1. Start **SmartView**. 2. Click the **Edit settings** button. 3. Click **Adv1** tab. 4. In combo box **Test images** choose **Image 1** or another test image.	1. Start **SmartView for WDM**. 2. In **Camera** menu click **Settings**. 3. Click **Adv1** tab. 4. In combo box **Test images** choose **Image 1** or another test image.	1. Start **cc1394** viewer. 2. In **Adjustments** menu click on **Picture Control**. 3. Click **Main** tab. 4. Activate Test image check box **on**. 5. In combo box **Test images** choose **Image 1** or another test image.

Table 113: Loading test images in different viewers

Test images for b/w cameras

The b/w cameras have two test images that look the same. Both images show a gray bar running diagonally (mirrored at the middle axis).

- **Image 1** is static.
- **Image 2** moves upwards by 1 pixel/frame.

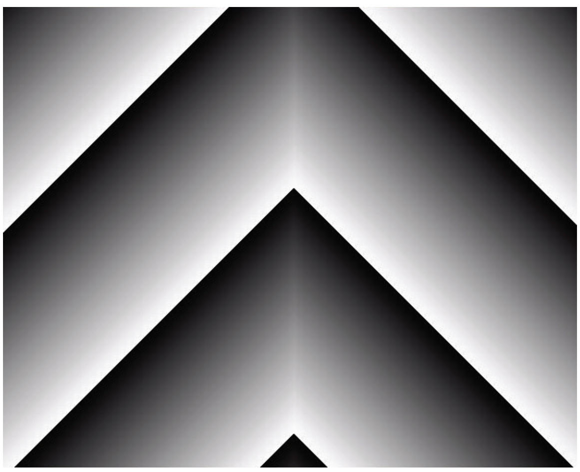


Figure 110: Gray bar test image

Test images for color cameras

The color cameras have 1 test image:

YUV4:2:2 mode

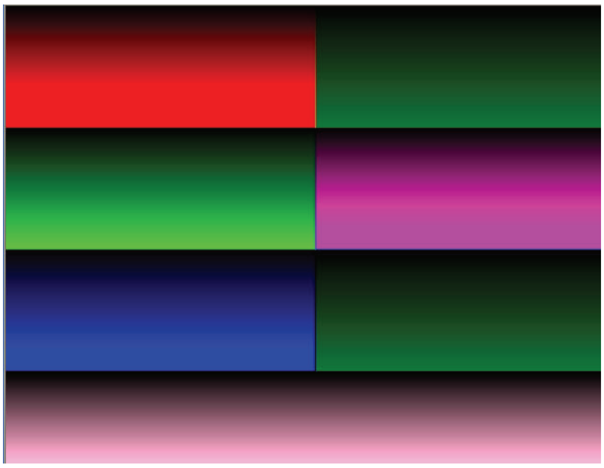


Figure 111: Color test image

Mono8 (raw data)

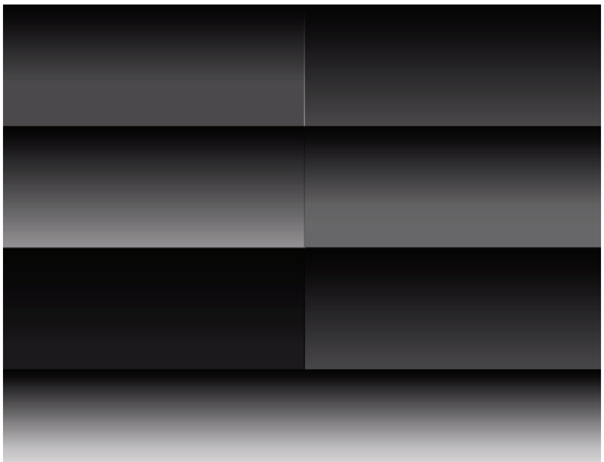


Figure 112: Bayer-coded test image

The color camera outputs Bayer-coded raw data in Mono8 instead of - as described in IIDC V1.31 - a real Y signal. The first pixel of the image is always the red pixel from the sensor. (Mirror must be switched off.)

Configuration of the camera

All camera settings are made by writing specific values into the corresponding registers.

This applies to:

- values for general operating states such as video formats and modes, exposure times, etc.
- extended features of the camera that are turned on and off and controlled via corresponding registers (so-called advanced registers).

Camera_Status_Register

The interoperability of cameras from different manufacturers is ensured by IIDC, formerly DCAM (Digital Camera Specification), published by the IEEE 1394 Trade Association.

IIDC is primarily concerned with setting memory addresses (e.g. CSR: Camera_Status_Register) and their meaning.

In principle all addresses in IEEE 1394 networks are 64 bits long.

The first 10 bits describe the Bus_Id, the next 6 bits the Node_Id.

Of the subsequent 48 bits, the first 16 bits are always FFFFh, leaving the description for the Camera_Status_Register in the last 32 bits.

If in the following, mention is made of a CSR F0F00600h, this means in full:

Bus_Id, Node_Id, FFFF F0F00600h

Writing and reading to and from the register can be done with programs such as **FireView** or by other programs developed using an API library (e.g. **FirePackage**).

Every register is 32 bit (big endian) and implemented as follows (MSB = Most Significant Bit; LSB = Least Significant Bit):

Far left

Bit 0	Bit 1	Bit 2	...	Bit 30	Bit 31
MSB					LSB

Table 114: 32-bit register

Example

This requires, for example, that to enable **ISO_Enabled mode** (see Chapter ISO_Enable / Free-Run on page 186), (bit 0 in register 614h), the value 80000000 h must be written in the corresponding register.

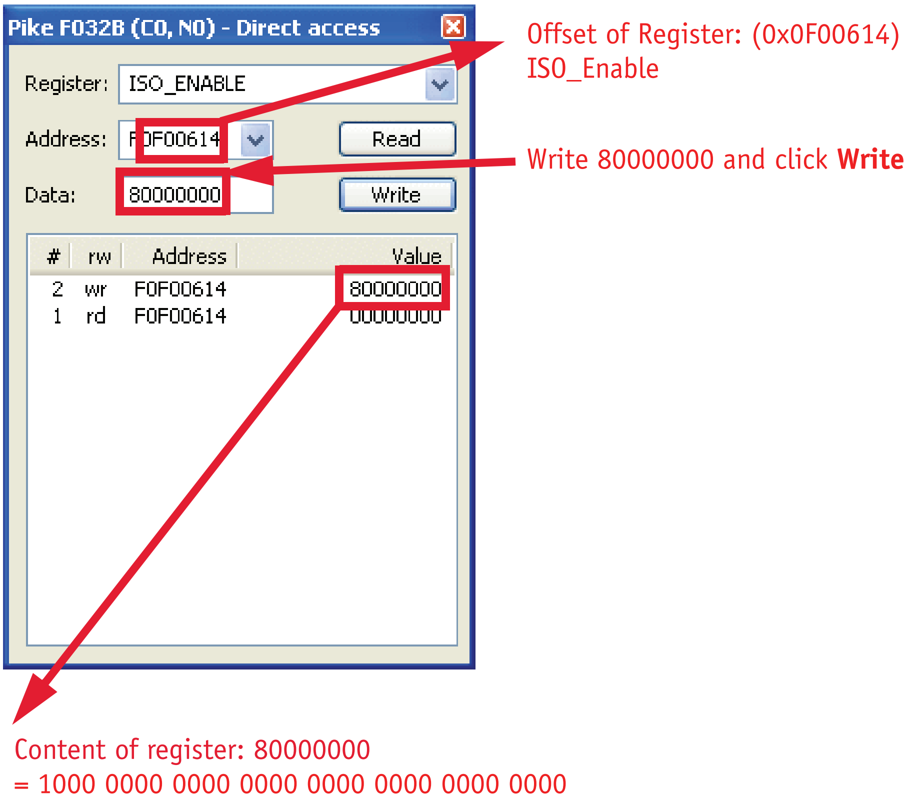
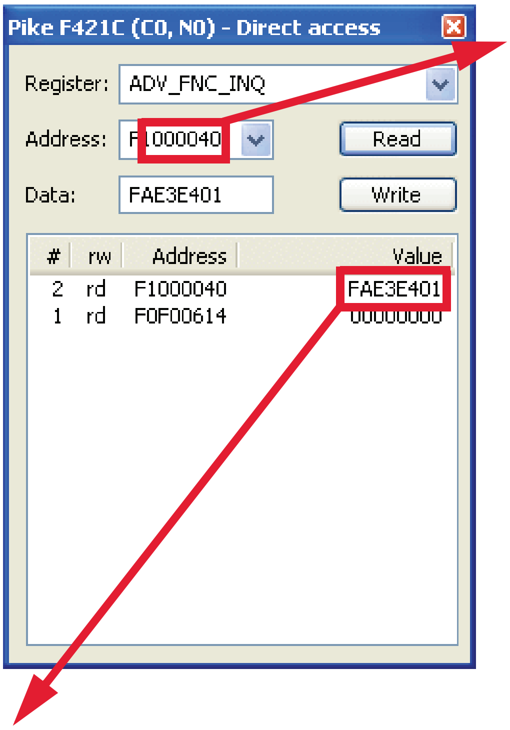


Figure 113: Enabling ISO_Enable



Offset of Register: (0x1000040)
ADV_FNC_INQ

Content of register: FAE3C401
= 1111 1010 1110 0011 1110 0100 0000 0001

Table 115: Configuring the camera (PIKE F-421C)

	MaxResolution	TimeBase	ExtdShutter	Testimage			VersionInfo		Look-up tables	Shading	DeferredTrans				Trigger Delay	Misc. features
Bit	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	1	1	1	1	1	0	1	0	1	1	1	0	0	0	1	1

	SoftReset	High SNR	ColorCorr			UserProfiles										GP_Buffer
Bit	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	1

Table 116: Configuring the camera: registers

Sample program

The following sample code in C/C++ shows how the register is set for video mode/format, trigger mode etc. using the **FireGrab** and **FireStack API**.

Example FireGrab

```
…
// Set Videoformat
  if(Result==FCE_NOERROR)
  Result= Camera.SetParameter(FGP_IMAGEFORMAT,MAKEIMAGEFORMAT(RES_640_480,
CM_Y8, FR_15));

  // Set external Trigger
  if(Result==FCE_NOERROR)
  Result= Camera.SetParameter(FGP_TRIGGER,MAKETRIGGER(1,0,0,0,0));

  // Start DMA logic
  if(Result==FCE_NOERROR)
   Result=Camera.OpenCapture();

  // Start image device
  if(Result==FCE_NOERROR)
   Result=Camera.StartDevice();

…
```

Example FireStack API

```
…
// Set framerate

Result=WriteQuad(HIGHOFFSET,m_Props.CmdRegBase+CCR_FRAMERATE,(UINT32)m_Parms.F
rameRate<<29);

  // Set mode
  if(Result)

Result=WriteQuad(HIGHOFFSET,m_Props.CmdRegBase+CCR_VMODE,(UINT32)m_Parms.Video
Mode<<29);

  // Set format
  if(Result)

Result=WriteQuad(HIGHOFFSET,m_Props.CmdRegBase+CCR_VFORMAT,(UINT32)m_Parms.Vid
eoFormat<<29);

  // Set trigger
  if(Result)
  {
    Mode=0;
    if(m_Parms.TriggerMode==TM_EXTERN)
     Mode=0x82000000;
    if(m_Parms.TriggerMode==TM_MODE15)
     Mode=0x820F0000;
    WriteQuad(HIGHOFFSET,m_Props.CmdRegBase+CCR_TRGMODE,Mode);
  }

  // Start continous ISO if not oneshot triggermode
  if(Result && m_Parms.TriggerMode!=TM_ONESHOT)
   Result=WriteQuad(HIGHOFFSET,m_Props.CmdRegBase+CCR_ISOENABLE,0x80000000);


…
```

Configuration ROM

The information in the Configuration ROM is needed to identify the node, its capabilities and which drivers are required.

The base address for the **configuration ROM** for all registers is FFFF F0000000h.

Note

If you want to use the **DirectControl** program to read or write to a register, enter the following value in the Address field:

F0F00000h + Offset

The ConfigRom is divided into

- Bus info block: providing critical information about the bus-related capabilities
- Root directory: specifying the rest of the content and organization, such as:
  - Node unique ID leaf
  - Unit directory and
  - Unit dependant info

The base address of the camera control register is calculated as follows based on the camera-specific base address:

	Offset	0-7	8-15	16-23	24-31	
Bus info block	400h	04	29	0C	C0	
	404h	31	33	39	34	.... ASCII for 1394
	408h	20	00	B2	03	.... Bus capabilities
	40Ch	00	0A	47	01	.... Node_Vendor_Id, Chip_id_hi
	410h	Serial number				.... Chip_id_lo
Root directory	414h	00	04	B7	85	According to IEEE1212, the root directory may have another length. The keys (e.g. 8D) point to the offset factors rather than the offset (e.g. 420h) itself.
	418h	03	00	0A	47	
	41Ch	0C	00	83	C0	
	420h	8D	00	00	02	
	424h	D1	00	00	04	

Table 117: Config ROM

The entry with key 8D in the root directory (420h in this case) provides the offset for the Node unique ID leaf.

To compute the effective start address of the node unique ID leaf:

To compute the effective start address of the node unique ID leaf	
currAddr	= node unique ID leaf address
destAddr	= address of directory entry
addrOffset	= value of directory entry
destAddr	= currAddr + (4 * addrOffset)
	= 420h + (4 * 000002h)
	= 428h

Table 118: Computing effective start address

420h + 000002 * 4 = 428h

	Offset	0-7	8-15	16-23	24-31	
→	428h	00	02	5E	9E	....CRC
Node unique ID leaf	42Ch	00	0A	47	01	....Node_Vendor_Id,Chip_id_hi
	430h	00	00	Serial number		

Table 119: Config ROM

The entry with key D1 in the root directory (424h in this case) provides the offset for the unit directory as follows:

424h + 000004 * 4 = 434h

	Offset	0-7	8-15	16-23	24-31
→	434h	00	03	93	7D
Unit directory	438h	12	00	A0	2D
	43Ch	13	00	01	02
	440h	D4	00	00	01

Table 120: Config ROM

The entry with key D4 in the unit directory (440h in this case) provides the offset for unit dependent info:

440h + 000001 * 4 = 444h

	Offset	0-7	8-15	16-23	24-31	
Unit dependent info	444h	00	0B	A9	6E	....unit_dep_info_length, CRC
	448h	40	3C	00	00	....command_regs_base
	44Ch	81	00	00	02	....vender_name_leaf
	450h	82	00	00	06	....model_name_leaf
	454h	38	00	00	10	....unit_sub_sw_version
	458h	39	00	00	00	....Reserved
	45Ch	3A	00	00	00	....Reserved
	460h	3B	00	00	00	....Reserved
	464h	3C	00	01	00	....vendor_unique_info_0
	468h	3D	00	92	00	....vendor_unique_info_1
	46Ch	3E	00	00	65	....vendor_unique_info_2
	470h	3F	00	00	00	....vendor_unique_info_3

Table 121: Config ROM

And finally, the entry with key 40 (448h in this case) provides the offset for the camera control register:

FFFF F0000000h + 3C0000h * 4 = FFFF F0F00000h

The base address of the camera control register is thus:

FFFF F0F00000h

The offset entered in the table always refers to the base address of F0F00000h.

Implemented registers

The following tables show how standard registers from IIDC V1.31 are implemented in the camera. Base address is F0F00000h. Differences and explanations can be found in the third column.

Camera initialize register

Offset	Name	Notes
000h	INITIALIZE	Assert MSB = 1 for Init.

Table 122: Camera initialize register

Inquiry register for video format

Offset	Name	Field	Bit	Description
100h	V_FORMAT_INQ	Format_0	[0]	Up to VGA (non compressed)
		Format_1	[1]	SVGA to XGA
		Format_2	[2]	SXGA to UXGA
		Format_3	[3..5]	Reserved
		Format_6	[6]	Still Image Format
		Format_7	[7]	Partial Image Format
		-	[8..31]	Reserved

Table 123: Format inquiry register

Inquiry register for video mode

Offset	Name	Field	Bit	Description
180h	V_MODE_INQ (Format_0)	Mode_0	[0]	160 x 120 YUV 4:4:4
		Mode_1	[1]	320 x 240 YUV 4:2:2
		Mode_2	[2]	640 x 480 YUV 4:1:1
		Mode_3	[3]	640 x 480 YUV 4:2:2
		Mode_4	[4]	640 x 480 RGB
		Mode_5	[5]	640 x 480 Mono8
		Mode_6	[6]	640 x 480 Mono16
		Mode_X	[7]	Reserved
		-	[8..31]	Reserved (zero)
184h	V_MODE_INQ (Format_1)	Mode_0	[0]	800 x 600 YUV 4:2:2
		Mode_1	[1]	800 x 600 RGB
		Mode_2	[2]	800 x 600 Mono8
		Mode_3	[3]	1024 x 768 YUV 4:2:2
		Mode_4	[4]	1024 x 768 RGB
		Mode_5	[5]	1024 x 768 Mono8
		Mode_6	[6]	800 x 600 Mono16
		Mode_7	[7]	1024 x 768 Mono16
		-	[8..31]	Reserved (zero)
188h	V_MODE_INQ (Format_2)	Mode_0	[0]	1280 x 960 YUV 4:2:2
		Mode_1	[1]	1280 x 960 RGB
		Mode_2	[2]	1280 x 960 Mono8
		Mode_3	[3]	1600 x 1200 YUV 4:2:2
		Mode_4	[4]	1600 x 1200 RGB
		Mode_5	[5]	1600 x 1200 Mono8
		Mode_6	[6]	1280 x 960 Mono16
		Mode_7	[7]	1600 x 1200 Mono16
		-	[8..31]	Reserved (zero)
18Ch … 197h	Reserved for other V_MODE_INQ_x for Format_x.			Always 0
198h	V_MODE_INQ_6 (Format_6)			Always 0

Table 124: Video mode inquiry register

Offset	Name	Field	Bit	Description
19Ch	V_MODE_INQ	Mode_0	[0]	Format_7 Mode_0
	(Format_7)	Mode_1	[1]	Format_7 Mode_1
		Mode_2	[2]	Format_7 Mode_2
		Mode_3	[3]	Format_7 Mode_3
		Mode_4	[4]	Format_7 Mode_4
		Mode_5	[5]	Format_7 Mode_5
		Mode_6	[6]	Format_7 Mode_6
		Mode_7	[7]	Format_7 Mode_7
		-	[8..31]	Reserved (zero)

Table 124: Video mode inquiry register

Inquiry register for video frame rate and base address

Offset	Name	Field	Bit	Description
200h	V_RATE_INQ	FrameRate_0	[0]	Reserved
	(Format_0, Mode_0)	FrameRate_1	[1]	Reserved
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	120 fps (V1.31)
		FrameRate_7	[7]	240 fps (V1.31)
		-	[8..31]	Reserved (zero)
204h	V_RATE_INQ	FrameRate_0	[0]	1.875 fps
	(Format_0, Mode_1)	FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	120 fps (V1.31)
		FrameRate_7	[7]	240 fps (V1.31)
		-	[8..31]	Reserved (zero)

Table 125: Frame rate inquiry register

Offset	Name	Field	Bit	Description
208h	V_RATE_INQ (Format_0, Mode_2)	FrameRate_0	[0]	1.875 fps
		FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	120 fps (V1.31)
		FrameRate_7	[7]	240 fps (V1.31)
		-	[8..31]	Reserved (zero)
20Ch	V_RATE_INQ (Format_0, Mode_3)	FrameRate_0	[0]	1.875 fps
		FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	120 fps (V1.31)
		FrameRate_7	[7]	240 fps (V1.31)
		-	[8..31]	Reserved (zero)
210h	V_RATE_INQ (Format_0, Mode_4)	FrameRate_0	[0]	1.875 fps
		FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	120 fps (V1.31)
		FrameRate_7	[7]	240 fps (V1.31)
		-	[8..31]	Reserved (zero)

Table 125: Frame rate inquiry register

Offset	Name	Field	Bit	Description
214h	V_RATE_INQ (Format_0, Mode_5)	FrameRate_0	[0]	1.875 fps
		FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	120 fps (V1.31)
		FrameRate_7	[7]	240 fps (V1.31)
		-	[8..31]	Reserved (zero)
218h	V_RATE_INQ	(Format_0, Mode_6) FrameRate_0	[0]	1.875 fps
		FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	120 fps (V1.31)
		FrameRate_7	[7]	240 fps (V1.31)
		-	[8..31]	Reserved (zero)
21Ch … 21Fh	Reserved V_RATE_INQ_0_x (for other Mode_x of Format_0)			Always 0
220h	V_RATE_INQ (Format_1, Mode_0)	FrameRate_0	[0]	Reserved
		FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	120 fps (V1.31)
		FrameRate_7	[7]	240 fps (V1.31)
		-	[8..31]	Reserved (zero)

Table 125: Frame rate inquiry register

Offset	Name	Field	Bit	Description
224h	V_RATE_INQ (Format_1, Mode_1)	FrameRate_0	[0]	Reserved
		FrameRate_1	[1]	Reserved
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	120 fps (V1.31)
		FrameRate_7	[7]	240 fps (V1.31)
		-	[8..31]	Reserved (zero)
228h	V_RATE_INQ (Format_1, Mode_2)	FrameRate_0	[0]	Reserved
		FrameRate_1	[1]	Reserved
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	120 fps (V1.31)
		FrameRate_7	[7]	240 fps (V1.31)
		-	[8..31]	Reserved (zero)
22Ch	V_RATE_INQ (Format_1, Mode_3)	FrameRate_0	[0]	1.875 fps
		FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	120 fps (V1.31)
		FrameRate_7	[7]	240 fps (V1.31)
		-	[8..31]	Reserved (zero)

Table 125: Frame rate inquiry register

Offset	Name	Field	Bit	Description
230h	V_RATE_INQ (Format_1, Mode_4)	FrameRate_0	[0]	1.875 fps
		FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	120 fps (V1.31)
		FrameRate_7	[7]	240 fps (V1.31)
		-	[8..31]	Reserved (zero)
234h	V_RATE_INQ (Format_1, Mode_5)	FrameRate_0	[0]	1.875 fps
		FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	120 fps (V1.31)
		FrameRate_7	[7]	240 fps (V1.31)
		-	[8..31]	Reserved (zero)
238h	V_RATE_INQ (Format_1, Mode_6)	FrameRate_0	[0]	1.875 fps
		FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	120 fps (V1.31)
		FrameRate_7	[7]	240 fps (V1.31)
		-	[8..31]	Reserved (zero)

Table 125: Frame rate inquiry register

Offset	Name	Field	Bit	Description
23Ch	V_RATE_INQ (Format_1, Mode_7)	FrameRate_0	[0]	1.875 fps
		FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	120 fps (V1.31)
		FrameRate_7	[7]	Reserved
		-	[8..31]	Reserved (zero)
240h	V_RATE_INQ (Format_2, Mode_0)	FrameRate_0	[0]	1.875 fps
		FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	Reserved
		FrameRate_7	[7]	Reserved
		-	[8..31]	Reserved (zero)
244h	V_RATE_INQ (Format_2, Mode_1)	FrameRate_0	[0]	1.875 fps
		FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	Reserved
		FrameRate_7	[7]	Reserved
		-	[8..31]	Reserved (zero)

Table 125: Frame rate inquiry register

Offset	Name	Field	Bit	Description
248h	V_RATE_INQ (Format_2, Mode_2)	FrameRate_0	[0]	1.875 fps
		FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	120 fps (V1.31)
		FrameRate_7	[7]	Reserved
		-	[8..31]	Reserved (zero)
24Ch	V_RATE_INQ (Format_2, Mode_3)	FrameRate_0	[0]	1.875 fps
		FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	Reserved
		FrameRate_7	[7]	Reserved
		-	[8..31]	Reserved (zero)
250h	V_RATE_INQ (Format_2, Mode_4)	FrameRate_0	[0]	1.875 fps
		FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	Reserved
		FrameRate_6	[6]	Reserved
		FrameRate_7	[7]	Reserved
		-	[8..31]	Reserved (zero)

Table 125: Frame rate inquiry register

Offset	Name	Field	Bit	Description
254h	V_RATE_INQ (Format_2, Mode_5)	FrameRate_0	[0]	1.875 fps
		FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	Reserved
		FrameRate_7	[7]	Reserved
		-	[8..31]	Reserved (zero)
258h	V_RATE_INQ (Format_2, Mode_6)	FrameRate_0	[0]	1.875 fps
		FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	Reserved
		FrameRate_7	[7]	Reserved
		-	[8..31]	Reserved (zero)
25Ch	V_RATE_INQ (Format_2, Mode_7)	FrameRate_0	[0]	1.875 fps
		FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	Reserved
		FrameRate_7	[7]	Reserved
		-	[8..31]	Reserved
260h … 2BFh	Reserved V_RATE_INQ_y_x (for other Format_y, Mode_x)			
2C0h	V_REV_INQ_6_0 (Format_6, Mode0)			Always 0
2C4h .. 2DFh	Reserved V_REV_INQ_6_x (for other Mode_x of Format_6)			Always 0

Table 125: Frame rate inquiry register

Offset	Name	Field	Bit	Description
2E0h		V-CSR_INQ_7_0	[0..31]	CSR_quadlet offset for Format_7 Mode_0
2E4h		V-CSR_INQ_7_1	[0..31]	CSR_quadlet offset for Format_7 Mode_1
2E8h		V-CSR_INQ_7_2	[0..31]	CSR_quadlet offset for Format_7 Mode_2
2ECh		V-CSR_INQ_7_3	[0..31]	CSR_quadlet offset for Format_7 Mode_3
2F0h		V-CSR_INQ_7_4	[0..31]	CSR_quadlet offset for Format_7 Mode_4
2F4h		V-CSR_INQ_7_5	[0..31]	CSR_quadlet offset for Format_7 Mode_5
2F8h		V-CSR_INQ_7_6	[0..31]	CSR_quadlet offset for Format_7 Mode_6
2FCh		V-CSR_INQ_7_7	[0..31]	CSR_quadlet offset for Format_7 Mode_7

Table 125: Frame rate inquiry register

Inquiry register for basic function

Offset	Name	Field	Bit	Description
400h	BASIC_FUNC_INQ	Advanced_Feature_Inq	[0]	Inquiry for advanced features (Vendor unique Features)
		Vmode_Error_Status_Inq	[1]	Inquiry for existence of Vmode_Error_Status register
		Feature_Control_Error_Status_Inq	[2]	Inquiry for existence of Feature_Control_Error_Status
		Opt_Func_CSR_Inq	[3]	Inquiry for Opt_Func_CSR
		-	[4..7]	
		1394b_mode_Capability	[8]	Inquiry for 1394b_mode_Capability
		-	[9..15]	Reserved
		Cam_Power_Cntl	[16]	Camera process power ON/OFF capability
		-	[17..18]	Reserved
		One_Shot_Inq	[19]	One Shot transmission capability
		Multi_Shot_Inq	[20]	Multi Shot transmission capability
		-	[21..27]	Reserved
		Memory_Channel	[28..31]	Maximum memory channel number (N) If 0000, no user memory available

Table 126: Basic function inquiry register

Inquiry register for feature presence

Offset	Name	Field	Bit	Description
404h	FEATURE_HI_INQ	Brightness	[0]	Brightness Control
		Auto_Exposure	[1]	Auto_Exposure Control
		Sharpness	[2]	Sharpness Control
		White_Balance	[3]	White_Balance Control
		Hue	[4]	Hue Control
		Saturation	[5]	Saturation Control
		Gamma	[6]	Gamma Control
		Shutter	[7]	Shutter Control
		Gain	[8]	Gain Control
		Iris	[9]	Iris Control
		Focus	[10]	Focus Control
		Temperature	[11]	Temperature Control
		Trigger	[12]	Trigger Control
		Trigger_Delay	[13]	Trigger_Delay Control
		White_Shading	[14]	White_Shading Control
		Frame_Rate	[15]	Frame_Rate Control
			[16..31]	Reserved
408h	FEATURE_LO_INQ	Zoom	[0]	Zoom Control
		Pan	[1]	Pan Control
		Tilt	[2]	Tilt Control
		Optical_Filter	[3]	Optical_Filter Control
			[4..15]	Reserved
		Capture_Size	[16]	Capture_Size for Format_6
		Capture_Quality	[17]	Capture_Quality for Format_6
			[16..31]	Reserved
40Ch	OPT_FUNCTION_INQ	-	[0]	Reserved
		PIO	[1]	Parallel Input/Output control
		SIO	[2]	Serial Input/Output control
		Strobe_out	[4..31]	Strobe signal output

Table 127: Feature presence inquiry register

Offset	Name	Field	Bit	Description
410h .. 47Fh	Reserved			Address error on access
480h	Advanced_Feature_Inq	Advanced_Feature_Quadlet_Offset	[0..31]	Quadlet offset of the advanced feature CSR's from the base address of initial register space (Vendor unique) This register is the offset for the Access_Control_Register and thus the base address for Advanced Features. Access_Control_Register does not prevent access to advanced features. In some programs it should still always be activated first. **Advanced Feature Set Unique Value** is 7ACh and **CompanyID** is A47h.
484h	PIO_Control_CSR_Inq	PIO_Control_Quadlet_Offset	[0..31]	Quadlet offset of the PIO_Control CSR's from the base address of initial register space (Vendor unique)
488h	SIO_Control_CSR_Inq	SIO_Control_Quadlet_Offset	[0..31]	Quadlet offset of the SIO_Control CSR's from the base address of initial register space (Vendor unique)
48Ch	Strobe_Output_CSR_Inq	Strobe_Output_Quadlet_Offset	[0..31]	Quadlet offset of the Strobe_Output signal CSR's from the base address of initial register space (Vendor unique)

Table 127: Feature presence inquiry register

Inquiry register for feature elements

Register	Name	Field	Bit	Description
0xF0F00500	BRIGHTNESS_INQUIRY	Presence_Inq	[0]	Indicates presence of this feature (read only)
		Abs_Control_Inq	[1]	Capability of control with absolute value
		-	[2]	Reserved
		One_Push_Inq	[3]	One Push auto mode (Controlled automatically by the camera once)
		Readout_Inq	[4]	Capability of reading out the value of this feature
		ON_OFF	[5]	Capability of switching this feature ON and OFF
		Auto_Inq	[6]	Auto Mode (Controlled automatically by the camera)
		Manual_Inq	[7]	Manual Mode (Controlled by user)
		Min_Value	[8..19]	Min. value for this feature
		Max_Value	[20..31]	Max. value for this feature
504h	AUTO_EXPOSURE_INQ	Same definition as Brightness_inq.		
508h	SHARPNESS_INQ	Same definition as Brightness_inq.		
50Ch	WHITE_BAL_INQ	Same definition as Brightness_inq.		
510h	HUE_INQ	Same definition as Brightness_inq.		
514h	SATURATION_INQ	Same definition as Brightness_inq.		
518h	GAMMA_INQ	Same definition as Brightness_inq.		
51Ch	SHUTTER_INQ	Same definition as Brightness_inq.		
520h	GAIN_INQ	Same definition as Brightness_inq.		
524h	IRIS_INQ	Always 0		
528h	FOCUS_INQ	Always 0		
52Ch	TEMPERATURE_INQ	Same definition as Brightness_inq.		

Table 128: Feature elements inquiry register

Register	Name	Field	Bit	Description
530h	TRIGGER_INQ	Presence_Inq	[0]	Indicates presence of this feature (read only)
		Abs_Control_Inq	[1]	Capability of control with absolute value
		-	[2..3	Reserved
		Readout_Inq	[4]	Capability of reading out the value of this feature
		ON_OFF	[5]	Capability of switching this feature ON and OFF
		Polarity_Inq	[6]	Capability of changing the polarity of the trigger input
			[7..15]	Reserved
		Trigger_Mode0_Inq	[16]	Presence of Trigger_Mode 0
		Trigger_Mode1_Inq	[17]	Presence of Trigger_Mode 1
		Trigger_Mode2_Inq	[18]	Presence of Trigger_Mode 2
		Trigger_Mode3_Inq	[19]	Presence of Trigger_Mode 3
			[20..31	Reserved
534h	TRIGGER_DELAY_INQUIRY	Presence_Inq	[0]	Indicates presence of this feature (read only)
		Abs_Control_Inq	[1]	Capability of control with absolute value
		-	[2]	Reserved
		One_Push_Inq	[3]	One Push auto mode Con-trolled automatically by the camera once)
		Readout_Inq	[4]	Capability of reading out the value of this feature
		ON_OFF	[5]	Capability of switching this feature ON and OFF
		Auto_Inq	[6]	Auto Mode (Controlled auto-matically by the camera)
		Manual_Inq	[7]	Manual Mode (Controlled by user)
		Min_Value	[8..19]	Min. value for this feature
		Max_Value	[20..31]	Max. value for this feature
538 .. 57Ch	Reserved for other FEATURE_HI_INQ			
580h	ZOOM_INQ	Always 0		
584h	PAN_INQ	Always 0		

Table 128: Feature elements inquiry register

Register	Name	Field	Bit	Description
588h	TILT_INQ	Always 0		
58Ch	OPTICAL_FILTER_INQ	Always 0		
590 .. 5BCh	Reserved for other FEATURE_LO_INQ	Always 0		
5C0h	CAPTURE_SIZE_INQ	Always 0		
5C4h	CAPTURE_QUALITY_INQ	Always 0		
5C8h .. 5FCh	Reserved for other FEATURE_LO_INQ	Always 0		
600h	CUR-V-Frm_RATE/Revision	Bits [0..2] for the frame rate		
604h	CUR-V-MODE	Bits [0..2] for the current video mode		
608h	CUR-V-FORMAT	Bits [0..2] for the current video format		
60Ch	ISO-Channel	Bits [0..3] for channel, [6..7] for ISO speed		
610h	Camera_Power	Always 0		
614h	ISO_EN/Continuous_Shot	Bit 0: 1 for start continuous shot; 0 for stop continuos shot		
618h	Memory_Save	Always 0		
61Ch	One_Shot, Multi_Shot, Count Number	See text		
620h	Mem_Save_Ch	Always 0		
624	Cur_Mem_Ch	Always 0		
628h	Vmode_Error_Status	Error in combination of Format/Mode/ISO Speed: Bit(0): No error; Bit(0)=1: error		

Table 128: Feature elements inquiry register

Inquiry register for absolute value CSR offset address

Offset	Name	Notes
700h	ABS_CSR_HI_INQ_0	Always 0
704h	ABS_CSR_HI_INQ_1	Always 0
708h	ABS_CSR_HI_INQ_2	Always 0
70Ch	ABS_CSR_HI_INQ_3	Always 0
710h	ABS_CSR_HI_INQ_4	Always 0
714h	ABS_CSR_HI_INQ_5	Always 0
718h	ABS_CSR_HI_INQ_6	Always 0
71Ch	ABS_CSR_HI_INQ_7	Always 0
720h	ABS_CSR_HI_INQ_8	Always 0
724h	ABS_CSR_HI_INQ_9	Always 0
728h	ABS_CSR_HI_INQ_10	Always 0
72Ch	ABS_CSR_HI_INQ_11	Always 0
730h	ABS_CSR_HI_INQ_12	Always 0
734 .. 77Fh	Reserved	Always 0
780h	ABS_CSR_LO_INQ_0	Always 0
784h	ABS_CSR_LO_INQ_1	Always 0
788h	ABS_CSR_LO_INQ_2	Always 0
78Ch	ABS_CSR_LO_INQ_3	Always 0
790h .. 7BFh	Reserved	Always 0
7C0h	ABS_CSR_LO_INQ_16	Always 0
7C4h	ABS_CSR_LO_INQ_17	Always 0
7C8h .. 7FFh	Reserved	Always 0

Table 129: Absolute value inquiry register

Status and control register for feature

The **OnePush** feature, WHITE_BALANCE, is currently implemented. If this flag is set, the feature becomes immediately active, even if no images are being input (see Chapter One-push automatic white balance on page 116).

Offset	Name	Field	Bit	Description
800h	BRIGHTNESS	Presence_Inq	[0]	Presence of this feature 0: N/A 1: Available
		Abs_Control	[1]	Absolute value control 0: Control with value in the Value field 1: Control with value in the Absolute value CSR If this bit = 1, value in the Value field is ignored.
			[2-4]	Reserved
		One_Push	[5]	Write '1': begin to work (Self cleared after operation) Read: Value='1' in operation Value='0' not in operation If A_M_Mode =1, this bit is ignored.
		ON_OFF	[6]	Write: ON or OFF this feature Read: read a status 0: OFF, 1: ON If this bit =0, other fields will be read only.
		A_M_Mode	[7]	Write: set the mode Read: read a current mode 0: Manual 1: Auto
			[8-19]	Reserved
		Value	[20-31]	Value. Write the value in Auto mode, this field is ignored. If "ReadOut" capability is not available, read value has no meaning.

Table 130: Feature control register

Offset	Name	Field	Bit	Description
804h	AUTO-EXPOSURE			See above Note: **Target grey level** parameter in SmartView corresponds to Auto_exposure register 0xF0F00804 (IIDC).
808h	SHARPNESS			See above

Table 130: Feature control register

Offset	Name	Field	Bit	Description
80Ch	WHITE-BALANCE	Presence_Inq	[0]	Presence of this feature 0: N/A 1: Available Always 0 for Mono
		Abs_Control	[1]	Absolute value control 0: Control with value in the Value field 1: Control with value in the Absolute value CSR If this bit = 1, value in the Value field is ignored.
			[2-4]	Reserved
		One_Push	[5]	Write '1': begin to work (Self cleared after operation) Read: Value='1' in operation Value='0' not in operation If A_M_Mode =1, this bit is ignored.
		ON_OFF	[6]	Write: ON or OFF this feature, Read: read a status 0: OFF 1: ON If this bit =0, other fields will be read only.
		A_M_Mode	[7]	Write: set the mode Read: read a current mode 0: Manual 1: Auto
		U_Value / B_Value	[8-19]	U Value / B_Value Write the value in AUTO mode, this field is ignored. If ReadOut capability is not available, read value has no meaning.
		V_Value / R_Value	[20-31]	V value / R value Write the value in AUTO mode, this field is ignored. If ReadOut capability is not available, read value has no meaning.

Table 130: Feature control register

Offset	Name	Field	Bit	Description
810h	HUE			See above Always 0 for Mono
814h	SATURATION			See above Always 0 for Mono
818h	GAMMA			See above
81Ch	SHUTTER			see Advanced Feature time base see Table 48: Shutter CSR on page 120
820h	GAIN			See above
824h	IRIS			Always 0
828h	FOCUS			Always 0
82Ch	TEMPERATURE			Always 0
830h	TRIGGER-MODE			Can be effected via advanced feature IO_INP_CTRLx.
834h .. 87C	Reserved for other FEATURE_HI			Always 0
880h	Zoom			Always 0
884h	PAN			Always 0
888h	TILT			Always 0
88Ch	OPTICAL_FILTER			Always 0
890 .. 8BCh	Reserved for other FEATURE_LO			Always 0
8C0h	CAPTURE-SIZE			Always 0
8C4h	CAPTURE-QUALITY			Always 0
8C8h .. 8FCh	Reserved for other FEATURE_LO			Always 0

Table 130: Feature control register

Feature control error status register

Offset	Name	Notes
640h	Feature_Control_Error_Status_HI	Always 0
644h	Feature_Control_Error_Status_LO	Always 0

Table 131: Feature control error register

Video mode control and status registers for Format_7

Quadlet offset Format_7 Mode_0

The quadlet offset to the base address for **Format_7 Mode_0**, which can be read out at F0F002E0h (according to Table 125: Frame rate inquiry register on page 256) gives 003C2000h.

4 x 3C2000h = F08000h so that the base address for the latter (Table 132: Format_7 control and status register on page 276) equals F0000000h + F08000h = F0F08000h.

Quadlet offset Format_7 Mode_1

The quadlet offset to the base address for **Format_7 Mode_1**, which can be read out at F0F002E4h (according to Table 125: Frame rate inquiry register on page 256) gives 003C2400h.

4 x 003C2400h = F09000h so that the base address for the latter (Table 132: Format_7 control and status register on page 276) equals F0000000h + F09000h = F0F09000h.

Format_7 control and status register (CSR)

Offset	Name	Notes
000h	MAX_IMAGE_SIZE_INQ	According to IIDC V1.31
004h	UNIT_SIZE_INQ	According to IIDC V1.31
008h	IMAGE_POSITION	According to IIDC V1.31
00Ch	IMAGE_SIZE	According to IIDC V1.31
010h	COLOR_CODING_ID	See note
014h	COLOR_CODING_INQ	According to IIDC V1.31

Table 132: Format_7 control and status register

Offset	Name	Notes
024h . . 033h	COLOR_CODING_INQ	Vendor Unique Color_Coding 0-127 (ID=128-255) **ID=132 ECCID_MONO12** **ID=136 ECCID_RAW12** ID=133 Reserved ID=134 Reserved ID=135 Reserved See Chapter Packed 12-Bit Mode on page 156.
034h	PIXEL_NUMER_INQ	According to IIDC V1.31
038h	TOTAL_BYTES_HI_INQ	According to IIDC V1.31
03Ch	TOTAL_BYTES_LO_INQ	According to IIDC V1.31
040h	PACKET_PARA_INQ	See note
044h	BYTE_PER_PACKET	According to IIDC V1.31

Table 132: Format_7 control and status register

Note

- For all modes in Format_7, **ErrorFlag_1** and **ErrorFlag_2** are refreshed on each access to the Format_7 Register.
- Contrary to IIDC DCAM V1.31, registers relevant to Format_7 are refreshed on each access. The **Setting_1** bit is automatically cleared after each access.
- When **ErrorFlag_1** or **ErrorFlag_2** are set and Format_7 is configured, no image capture is started.
- Contrary to IIDC V1.31, COLOR_CODING_ID is set to a default value after an INITIALIZE or **reset**.
- Contrary to IIDC V1.31, the **UnitBytePerPacket** field is already filled in with a fixed value in the PACKET_PARA_INQ register.

Advanced features

The camera has a variety of extended features going beyond the possibilities described in IIDC V1.31 The following chapter summarizes all available advanced features in ascending register order.

The following table gives an overview of all available registers:

Register	Register name	Remarks
0XF1000010	VERSION_INFO1	see Table 134: Extended version information register on page 281
0XF1000018	VERSION_INFO3	
0XF1000040	ADV_INQ_1	see Table 136: Advanced feature inquiry register on page 283 In ADV_INQ_3 there is a new field F7MODE_MAPPING [3]
0XF1000044	ADV_INQ_2	
0XF1000048	ADV_INQ_3	
0XF100004C	ADV_INQ_4	
0xF1000100	CAMERA_STATUS	see Table 137: Camera status register on page 285
0XF1000200	MAX_RESOLUTION	see Table 138: Max. resolution inquiry register on page 286
0XF1000208	TIMEBASE	see Table 139: Time base configuration register on page 286
0XF100020C	EXTD_SHUTTER	see Table 141: Extended shutter configuration register on page 288
0XF1000210	TEST_IMAGE	see Table 142: Test image configuration register on page 289
0XF1000220	SEQUENCE_CTRL	Table 79: Sequence configuration register on page 190
0XF1000224	SEQUENCE_PARAM	
0XF1000228	SEQUENCE_STEP	
0XF100022C	SEQUENCE_RESET	
0XF1000240	LUT_CTRL	see Table 143: LUT control register on page 290
0XF1000244	LUT_MEM_CTRL	
0XF1000248	LUT_INFO	
0XF1000250	SHDG_CTRL	see Table 144: Shading control register on page 293
0XF1000254	SHDG_MEM_CTRL	
0XF1000258	SHDG_INFO	
0XF1000260	DEFERRED_TRANS	see Table 146: Deferred image configuration register on page 296
0XF1000270	FRAMEINFO	see Table 147: Frame information configuration register on page 297
0XF1000274	FRAMECOUNTER	

Table 133: Advanced registers summary

Register	Register name	Remarks
0XF1000300	IO_INP_CTRL1	see Table 33: Input configuration register on page 95
0XF1000304	IO_INP_CTRL2	
0XF1000308	IO_INP_CTRL3	
0XF100030C	IO_INP_CTRL4	
0XF1000320	IO_OUTP_CTRL1	see Table 39: Output configuration register on page 103
0XF1000324	IO_OUTP_CTRL2	
0XF1000328	IO_OUTP_CTRL3	
0XF100032C	IO_OUTP_CTRL4	
0XF1000340	IO_INTENA_DELAY	see Table 148: Delayed integration enable configuration register on page 298
0XF1000360	AUTOSHUTTER_CTRL	see Table 149: Auto shutter control advanced register on page 299
0XF1000364	AUTOSHUTTER_LO	
0XF1000368	AUTOSHUTTER_HI	
0XF1000370	AUTOGAIN_CTRL	see Table 150: Advanced register for auto gain control on page 300
0XF1000390	AUTOFNC_AOI	see Table 151: Advanced register for autofunction AOI on page 301
0XF1000394	AF_AREA_POSITION	
0XF1000398	AF_AREA_SIZE	
0XF10003A0	COLOR_CORR	Pike color cameras only see Table 152: Color correction on page 303
0xF10003A4	COLOR_CORR_COEFFIC11 = Crr	Pike color camera only see Table 152: Color correction on page 303
0xF10003A8	COLOR_CORR_COEFFIC12 = Cgr	
0xF10003AC	COLOR_CORR_COEFFIC13 = Cbr	
0xF10003B0	COLOR_CORR_COEFFIC21 = Crg	
0xF10003B4	COLOR_CORR_COEFFIC22 = Cgg	
0xF10003B8	COLOR_CORR_COEFFIC23 = Cbg	
0xF10003BC	COLOR_CORR_COEFFIC31 = Crb	
0xF10003C0	COLOR_CORR_COEFFIC32 = Cgb	
0xF10003C4	COLOR_CORR_COEFFIC33 = Cbb	
0XF1000400	TRIGGER_DELAY	see Table 153: Trigger delay advanced CSR on page 304
0XF1000410	MIRROR_IMAGE	see Table 154: Mirror control register on page 304
0XF1000420	AFE_CHN_COMP	see Table 155: Channel balance register on page 305
0XF1000424		
0XF1000428		

Table 133: Advanced registers summary

Register	Register name	Remarks
0XF1000440	LOW_SMEAR	see Chapter Smear reduction on page 317
0XF1000510	SOFT_RESET	see Table 156: Soft reset register on page 305
0XF1000520	HIGH_SNR	see Table 157: High Signal Noise Ratio (HSNR) on page 306
0X1000550	USER PROFILES	see Table 169: User profiles on page 317
0X1000620	TRIGGER_COUNTER	see Table 166: Advanced register: trigger counter on page 315
0X1000630	SIS	
0X1000560	F7MODE_MAPPING	see Format_7 mode mapping on page 310
0X1000570	PARAMUPD_TIMING	see Chapter Quick parameter change timing modes on page 307
0XF1000FFC	GPDATA_INFO	see Table 172: GPData buffer register on page 320
0XF1001000 ... 0XF100nnnn	GPDATA_BUFFER	
0x1100000	PARRAMLIST_INFO	see Chapter Parameter-List Update on page 309
0x1101000	PARAMLIST_BUFFER	

Table 133: Advanced registers summary

Note

Advanced features should always be activated before accessing them.

Note

- Currently all registers can be written without being activated. This makes it easier to operate the camera using **Directcontrol**.
- AVT reserves the right to require activation in future versions of the software.

Extended version information register

The presence of each of the following features can be queried by the **0** bit of the corresponding register.

Register	Name	Field	Bit	Description
0xF1000010	VERSION_INFO1	µC type ID	[0..15]	Always 0
		µC version	[16..31]	Bcd-coded version number
0xF1000014	VERSION_INFO1_EX	µC version	[0..31]	Bcd-coded version number
0xF1000018	VERSION_INFO3	Camera type ID	[0..15]	See Table 135: Camera type ID list on page 282.
		FPGA version	[16..31]	Bcd-coded version number
0xF100001C	VERSION_INFO3_EX	FPGA version	[0..31]	Bcd-coded version number
0xF1000020		---	[0..31]	Reserved
0xF1000024		---	[0..31]	Reserved
0xF1000028		---	[0..31]	Reserved
0xF100002C		---	[0..31]	Reserved
0xF1000030		OrderIDHigh	[0..31]	8 Byte ASCII Order ID
0xF1000034		OrderIDLow	[0..31]	

Table 134: Extended version information register

The µC version and FPGA firmware version numbers are bcd-coded, which means that e.g. firmware version 0.85 is read as 0x0085 and version 1.10 is read as 0x0110.

The newly added **VERSION_INFOx_EX** registers contain extended bcd-coded version information formatted as *special.major.minor.patch*.

So reading the value **0x00223344** is decoded as:

- special: 0 (decimal)
- major: 22 (decimal)
- minor: 33 (decimal)
- patch: 44 (decimal)

This is decoded to the human readable version **22.33.44** (leading zeros are omitted).

Note

If a camera returns the register set to all zero, that particular camera does not support the extended version information.

The FPGA type ID (= camera type ID) identifies the camera type with the help of the following list:

ID	Camera type
101	PIKE F-032B
102	PIKE F-032C
103	PIKE F-100B
104	PIKE F-100C
105	PIKE F-145B
106	PIKE F-145C
107	PIKE F-210B
108	PIKE F-210C
109	-
110	-
111	PIKE F-421B
112	PIKE F-421C
113	-
114	-
115	PIKE F-145B-15fps
116	PIKE F-145C-15fps
117	PIKE F-505B
118	PIKE F-505C

Table 135: Camera type ID list

Advanced feature inquiry

This register indicates with a named bit if a feature is present or not. If a feature is marked as not present the associated register space might not be available and read/write errors may occur.

Note

Ignore unnamed bits in the following table: these bits might be set or not.

Register	Name	Field	Bit	Description
0xF1000040	ADV_INQ_1	MaxResolution	[0]	
		TimeBase	[1]	
		ExtdShutter	[2]	
		TestImage	[3]	
		FrameInfo	[4]	
		Sequences	[5]	
		VersionInfo	[6]	
		---	[7]	Reserved
		Look-up tables	[8]	
		Shading	[9]	
		DeferredTrans	[10]	
		HDR mode	[11]	
		---	[12]	Reserved
		---	[13]	Reserved
		TriggerDelay	[14]	
		Mirror image	[15]	
		Soft Reset	[16]	
		High SNR	[17]	
		Color Correction	[18]	
		---	[19..20]	Reserved
		User Sets	[21]	
		---	[22..29]	Reserved
		Paramlist_Info	[30]	
		GP_Buffer	[31]	

Table 136: Advanced feature inquiry register

Register	Name	Field	Bit	Description
0xF1000044	ADV_INQ_2	Input_1	[0]	
		Input_2	[1]	
		---	[2..7]	Reserved
		Output_1	[8]	
		Output_2	[9]	
		Output_3	[10]	
		Output_4	[11]	
		---	[12..15]	Reserved
		IntEnaDelay	[16]	
		---	[17..31]	Reserved
0xF1000048	ADV_INQ_3	Camera Status	[0]	
		---	[1]	Reserved
		Paramupd_Timing	[2]	
		F7 mode mapping	[3]	
		Auto Shutter	[4]	
		Auto Gain	[5]	
		Auto FNC AOI	[6]	
		---	[7..31]	Reserved
0xF100004C	ADV_INQ_4	HDR Pike	[0]	
		Channel Compensation	[1]	
		Smear reduction	[2]	
		---	[18..31]	Reserved

Table 136: Advanced feature inquiry register

Camera status

This register allows to determine the current status of the camera. The most important flag is the **Idle** flag.

If the **Idle** flag is set the camera does not capture and does not send any images (but images might be present in the image FIFO).

The **ExSyncArmed** flag indicates that the camera is set up for external triggering. Even if the camera is waiting for an external trigger event the **Idle** flag might get set.

Other bits in this register might be set or toggled: just ignore these bits.

Note

- Excessive polling of this register may slow down the operation of the camera. Therefore the time between two polls of the status register should not be less than 5 milliseconds. If the time between two read accesses is lower than 5 milliseconds the response will be delayed.
- Depending on shutter and isochronous settings the status flags might be set for a very short time and thus will not be recognized by your application.

Register	Name	Field	Bit	Description
0xF1000100	CAMERA_STATUS	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..23]	Reserved
		ID	[24..31]	Implementation ID = 0x01
0xF1000104		---	[0..14]	Reserved
		ExSyncArmed	[15]	External trigger enabled
		---	[16..27]	Reserved
		ISO	[28]	Isochronous transmission
		---	[29..30]	Reserved
		Idle	[31]	Camera idle

Table 137: Camera status register

Maximum resolution

This register indicates the highest resolution for the sensor and is read-only.

This register normally outputs the MAX_IMAGE_SIZE_INQ Format_7 Mode_0 value.

Register	Name	Field	Bit	Description
0xF1000200	MAX_RESOLUTION	MaxHeight	[0..15]	Sensor height (read only)
		MaxWidth	[16..31]	Sensor width (read only)

Table 138: Max. resolution inquiry register

Time base

Corresponding to IIDC, exposure time is set via a 12-bit value in the corresponding register (SHUTTER_INQ [51Ch] and SHUTTER [81Ch]).

This means that a value in the range of 1 to 4095 can be entered.

PIKE cameras use a time base which is multiplied by the shutter register value. This multiplier is configured as the time base via the TIMEBASE register.

Register	Name	Field	Bit	Description
0xF1000208	TIMEBASE	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..7]	Reserved
		ExpOffset	[8..19]	Exposure offset in µs
		---	[20..27]	Reserved
		Timebase_ID	[28..31]	See Table 140: Time base ID on page 287.

Table 139: Time base configuration register

The time base IDs 0-9 are in bits 28 to 31. See Table 140: Time base ID on page 287.

Default time base is 20 µs: This means that the integration time can be changed in 20 µs increments with the shutter control.

Note

Time base can only be changed when the camera is in idle state and becomes active only after setting the shutter value.

The **ExpOffset** field specifies the camera specific exposure time offset in microseconds (µs). This time (which should be equivalent to Table 71: Camera-specific exposure time offset on page 180) has to be added to the exposure time (set by any shutter register) to compute the real exposure time.

If **ExpOffset** = zero: unknown exposure time offset.

ID	Time base in µs	
0	1	
1	2	
2	5	
3	10	
4	**20**	**Default value**
5	50	
6	100	
7	200	
8	500	
9	1000	

Table 140: Time base ID

Note

The ABSOLUTE VALUE CSR register, introduced in IIDC V1.3, is not implemented.

Extended shutter

The exposure time for long-term integration of up to 67 seconds can be entered with µs precision via the EXTENDED_SHUTTER register.

Register	Name	Field	Bit	Description
0xF100020C	EXTD_SHUTTER	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	Reserved
		ExpTime	[6..31]	Exposure time in µs

Table 141: Extended shutter configuration register

The minimum allowed exposure time depends on the camera model. To determine this value write **1** to the **ExpTime** field and read back the minimum allowed exposure time.

The longest exposure time, 3FFFFFFh, corresponds to 67.11 sec.

Note

- Exposure times entered via the 81Ch register are mirrored in the extended register, but not vice versa.
- Changes in this register have immediate effect, even when camera is transmitting.
- Extended shutter becomes inactive after writing to a format / mode / frame rate register.
- Extended shutter setting will thus be overwritten by the normal time base/shutter setting after Stop/Start of FireView or FireDemo.

Test images

Bits **8-14** indicate which test images are saved. Setting bits **28-31** activates or deactivates existing test images.

By activating any test image the following auto features are automatically disabled:

- auto gain
- auto shutter
- auto white balance

Register	Name	Field	Bit	Description
0xF1000210	TEST_IMAGE	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..7]	Reserved
		Image_Inq_1	[8]	Presence of test image 1 0: N/A 1: Available
		Image_Inq_2	[9]	Presence of test image 2 0: N/A 1: Available
		Image_Inq_3	[10]	Presence of test image 3 0: N/A 1: Available
		Image_Inq_4	[11]	Presence of test image 4 0: N/A 1: Available
		Image_Inq_5	[12]	Presence of test image 5 0: N/A 1: Available
		Image_Inq_6	[13]	Presence of test image 6 0: N/A 1: Available
		Image_Inq_7	[14]	Presence of test image 7 0: N/A 1: Available
		---	[15..27]	Reserved
		TestImage_ID	[28..31]	0: No test image active 1: Image 1 active 2: Image 2 active …

Table 142: Test image configuration register

Look-up tables (LUT)

Load the look-up tables to be used into the camera and choose the look-up table number via the **LutNo** field. Now you can activate the chosen LUT via the LUT_CTRL register.

The LUT_INFO register indicates how many LUTs the camera can store and shows the maximum size of the individual LUTs.

The possible values for **LutNo** are 0..n-1, whereas n can be determined by reading the field **NumOfLuts** of the LUT_INFO register.

Register	Name	Field	Bit	Description
0xF1000240	LUT_CTRL	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	Reserved
		ON_OFF	[6]	Enable/disable this feature
		---	[7..25]	Reserved
		LutNo	[26..31]	Use look-up table with **LutNo** number
0xF1000244	LUT_MEM_CTRL	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..4]	Reserved
		EnableMemWR	[5]	Enable write access
		---	[6..7]	Reserved
		AccessLutNo	[8..15]	Reserved
		AddrOffset	[16..31]	byte
0xF1000248	LUT_INFO	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..2]	Reserved
		BitsPerValue	[3..7]	Bits used per table item
		NumOfLuts	[8..15]	Maximum number of look-up tables
		MaxLutSize	[16..31]	Maximum look-up table size (bytes)

Table 143: LUT control register

Note

The **BitsPerValue** field indicates how many bits are read from the LUT for any gray-value read from the sensor. To determine the number of bytes occupied for each gray-value round-up the **BitsPerValue** field to the next byte boundary.

Examples:

- BitsPerValue = 8 → 1 byte per gray-value
- BitsPerValue = 14 → 2 byte per gray-value

Divide **MaxLutSize** by the number of bytes per gray-value in order to get the number of bits read from the sensor.

Note

Pike cameras have the gamma feature implemented via a built-in look-up table. Therefore you can not use gamma and your own look-up table at the same time. Nevertheless you may combine a gamma look-up table into your own look-up table.

Note

When using the LUT feature and the gamma feature pay attention to the following:

- gamma ON → look-up table is switched ON also
- gamma OFF → look-up table is switched OFF also
- look-up table OFF → gamma is switched OFF also
- look-up table ON → gamma is switched OFF

Loading a look-up table into the camera

Loading a look-up table into the camera is done through the GPDATA_BUFFER. Because the size of the GPDATA_BUFFER is smaller than a complete look-up table the data must be written in multiple steps.

To load a lookup table into the camera:

1. Query the limits and ranges by reading LUT_INFO and GPDATA_INFO.
2. Set **EnableMemWR** to true (1).
3. Set **AccessLutNo** to the desired number.
4. Set **AddrOffset** to 0.
5. Write n lookup table data bytes to GPDATA_BUFFER (n might be lower than the size of the GPDATA_BUFFER; AddrOffset is automatically adjusted inside the camera).
6. Repeat step 5 until all data is written into the camera.
7. Set **EnableMemWR** to false (0).

Shading correction

Owing to technical circumstances, the interaction of recorded objects with one another, optical effects and lighting non-homogeneities may occur in the images.

Because these effects are normally not desired, they should be eliminated as far as possible in subsequent image editing. The camera has automatic shading correction to do this.

Provided that a shading image is present in the camera, the **on/off** bit can be used to enable shading correction.

The **on/off** and **ShowImage** bits must be set for saved shading images to be displayed.

Note

- Always make sure that the shading image is saved at the highest resolution of the camera. If a lower resolution is chosen and ShowImage is set to **true**, the image will not be displayed correctly.
- The shading image is computed using the current video settings. On fixed video modes the selected frame rate also affects the computation time.
- The build process will not work, if a MONO16/RGB16 format is active.

Register	Name	Field	Bit	Description
0xF1000250	SHDG_CTRL	Presence_Inq	[0]	Indicates presence of this feature (read only)
		BuildError	[1]	Could not built shading image
		---	[2..3]	Reserved
		ShowImage	[4]	Show shading data as image
		BuildImage	[5]	Build a new shading image
		ON_OFF	[6]	Shading on/off
		Busy	[7]	Build in progress
		MemChannelSave	[8]	Save shading data in flash memory
		MemChannelLoad	[9]	Load shading data from flash memory
		MemChannelClear	[10]	Erase flash memory
		---	[11..15]	Reserved
		MemChannelError	[16..19]	Indicates memory channel error. See Table 145: Memory channel error description on page 295.
		MemoryChannel	[20..23]	Set memory channel number for save and load operations
		GrabCount	[24..31]	Number of images
0xF1000254	SHDG_MEM_CTRL	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..4]	Reserved
		EnableMemWR	[5]	Enable write access
		EnableMemRD	[6]	Enable read access
		---	[7]	Reserved
		AddrOffset	[8..31]	In bytes
0xF1000258	SHDG_INFO	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..3]	Reserved
		MaxMemChannel	[4..7]	Maximum number of available memory channels to store shading images
		MaxImageSize	[8..31]	Maximum shading image size (in bytes)

Table 144: Shading control register

Reading or writing shading image from/into the camera

Accessing the shading image inside the camera is done through the GPDATA_BUFFER. Because the size of the GPDATA_BUFFER is smaller than a whole shading image the data must be written in multiple steps.

To read or write a shading image:

1. Query the limits and ranges by reading SHDG_INFO and GPDATA_INFO.
2. Set **EnableMemWR** or **EnableMemRD** to true (1).
3. Set **AddrOffset** to 0.
4. Write n shading data bytes to GPDATA_BUFFER (n might be lower than the size of the GPDATA_BUFFER; AddrOffset is automatically adjusted inside the camera).
5. Repeat step 4 until all data is written into the camera.
6. Set **EnableMemWR** and **EnableMemRD** to false.

Automatic generation of a shading image

Shading image data may also be generated by the camera. To use this feature make sure all settings affecting an image are set properly. The camera uses the current active resolution to generate the shading image.

To generate a shading image:

1. Set **GrabCount** to the number of the images to be averaged before the correction factors are calculated.
2. Set **BuildImage** to true.
3. Poll the SHDG_CTRL register until the **Busy** and **BuildImage** flags are reset automatically.

The maximum value of GrabCount depends on the camera type and the number of available image buffers. GrabCount is automatically adjusted to a power of two.

Do not poll the SHDG_CTRL register too often, while automatic generation is in progress. Each poll delays the process of generating the shading image. An optimal poll interval time is 500 ms.

Non-volatile memory operations

Pike cameras support storing shading image data into non-volatile memory. Once a shading image is stored it is automatically reloaded on each camera reset.

MaxMemChannel indicates the number of so-called memory channels/slots available for storing shading images.

To store a shading image into non-volatile memory:

1. Set **MemoryChannel** to the desired memory channel and **MemoryChannelSave** to true (1).
2. Read **MemoryChannelError** to check for errors.

To reload a shading image from non-volatile memory:

1. Set **MemoryChannel** to the desired memory channel and **MemChannelLoad** to true (1).
2. Read **MemChannelError** to check for errors.

To clear already stored shading image data in non-volatile memory (shading image data won't be loaded on camera resets):

1. Set **MemoryChannel** to the desired memory channel and **MemChannelClear** to true (1).
2. Read **MemChannelError** to check for errors.

Memory channel error codes

ID	Error description
0x00	No error
0x01	Memory detection error
0x02	Memory size error
0x03	Memory erase error
0x04	Memory write error
0x05	Memory header write error
0x0F	Memory channel out of range

Table 145: Memory channel error description

Deferred image transport

Using this register, the sequence of recording and the transfer of the images can be paused. Setting **HoldImg** prevents transfer of the image. The images are stored in **ImageFIFO**.

The images indicated by **NumOfImages** are sent by setting the **SendImage** bit.

When **FastCapture** is set (in Format_7 only), images are recorded at the highest possible frame rate.

Register	Name	Field	Bit	Description
0xF1000260	DEFERRED_TRANS	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..4]	Reserved
		SendImage	[5]	Send NumOfImages now (auto reset)
		HoldImg	[6]	Enable/Disable deferred transport mode
		FastCapture	[7]	Enable/disable fast capture mode
		---	[8..15]	Reserved
		FiFoSize	[16..23]	Size of FiFo in number of images (read only)
		NumOfImages	[24..31]	Write: Number of images to send Read: Number of images in buffer

Table 146: Deferred image configuration register

Frame information

Register	Name	Field	Bit	Description
0xF1000270	FRAMEINFO	Presence_Inq	[0]	Indicates presence of this feature (read only)
		ResetFrameCnt	[1]	Reset frame counter
		---	[1..31]	Reserved
0xF1000274	FRAMECOUNTER	FrameCounter	[0..31]	Number of captured frames since last reset

Table 147: Frame information configuration register

The **FrameCounter** is incremented when an image is read out of the sensor.

The **FrameCounter** does not indicate whether an image was sent over the IEEE 1394 bus or not.

Input/output pin control

See Chapter Input/output pin control on page 95

Triggers

See Chapter Triggers on page 94

IO_INP_CTRL 1-2

See Chapter IO_INP_CTRL 1-2 on page 96

IO_OUTP_CTRL 1-4

See Chapter IO_OUTP_CTRL 1-4 on page 103

Output mode

See Chapter Output modes on page 104

Delayed Integration enable

A delay time between initiating exposure on the sensor and the activation edge of the **IntEna** signal can be set using this register. The **on/off** flag activates/deactivates integration delay. The time can be set in µs in **DelayTime**.

Note

- Please note that only one edge is delayed.
- If **IntEna_Out** is used to control an exposure, it is possible to have a variation in brightness or to precisely time a flash.

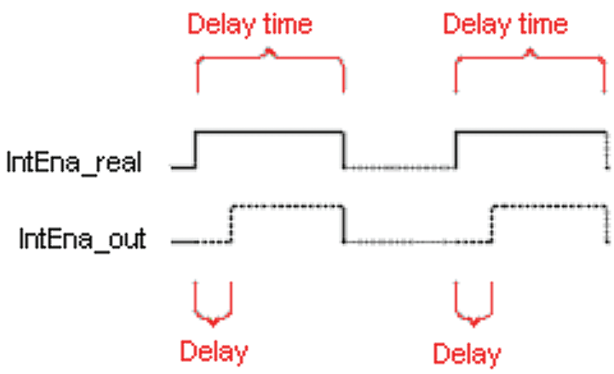


Figure 114: Delayed integration timing

Register	Name	Field	Bit	Description
0xF1000340	IO_INTENA_DELAY	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	Reserved
		ON_OFF	[6]	Enable/disable integration enable delay
		---	[7..11]	Reserved
		DELAY_TIME	[12..31]	Delay time in µs

Table 148: Delayed integration enable configuration register

Auto shutter control

The table below illustrates the advanced register for **auto shutter control**. The purpose of this register is to limit the range within which auto shutter operates.

Register	Name	Field	Bit	Description
0xF1000360	AUTOSHUTTER_CTRL	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..31]	Reserved
0xF1000364	AUTOSHUTTER_LO	---	[0..5]	Reserved
		MinValue	[6..31]	Minimum auto shutter value lowest possible value: 10 µs
0xF1000368	AUTOSHUTTER_HI	---	[0..5]	Reserved
		MaxValue	[0..31]	Maximum auto shutter value

Table 149: Auto shutter control advanced register

Note

- Values can only be changed within the limits of shutter CSR.
- Changes in auto exposure register only have an effect when auto shutter is enabled.
- Auto exposure limits are: 50..205 (**SmartView→Ctrl1 tab**: **Target grey level**)

When both auto shutter and auto gain are enabled, priority is given to increasing shutter when brightness decreases. This is done to achieve the best image quality with lowest noise.

For increasing brightness, priority is given to lowering gain first for the same purpose.

MinValue and **MaxValue** limits the range the auto shutter feature is allowed to use for the regulation process. Both values are initialized with the minimum and maximum value defined in the standard SHUTTER_INQ register (multiplied by the current active timebase).

If you change the **MinValue** and/or **MaxValue** and the new range exceeds the range defined by the SHUTTER_INQ register, the standard SHUTTER register will not show correct shutter values. In this case you should read the EXTENDED_SHUTTER register for the current active shutter time.

Changing the auto shutter range might not affect the regulation, if the regulation is in a stable condition and no other condition affecting the image brightness is changed.

If both auto gain and auto shutter are enabled and if the shutter is at its upper boundary and gain regulation is in progress, increasing the upper auto shutter boundary has no effect on auto gain/shutter regulation as long as auto gain regulation is active.

Note

As with the Extended Shutter the value of **MinValue** and **MaxValue** must not be set to a lower value than the minimum shutter time.

Auto gain control

The table below illustrates the advanced register for auto gain control.

Register	Name	Field	Bit	Description
0xF1000370	AUTOGAIN_CTRL	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..3]	Reserved
		MaxValue	[4..15]	Maximum auto gain value
		---	[16..19]	Reserved
		MinValue	[20..31]	Minimum auto gain value

Table 150: Advanced register for auto gain control

MinValue and **MaxValue** limits the range the auto gain feature is allowed to use for the regulation process. Both values are initialized with the minimum and maximum value defined in the standard GAIN_INQ register.

Changing the auto gain range might not affect the regulation, if the regulation is in a stable condition and no other condition affecting the image brightness is changed.

If both auto gain and auto shutter are enabled and if the gain is at its lower boundary and shutter regulation is in progress, decreasing the lower auto gain boundary has no effect on auto gain/shutter regulation as long as auto shutter regulation is active.

Both values can only be changed within the range defined by the standard GAIN_INQ register.

Autofunction AOI

The table below illustrates the advanced register for autofunction AOI.

AOI means **area of interest**.

Use this feature to select the image area (work area) on which the following autofunctions work:

- auto shutter
- auto gain
- auto white balance

Note

Autofunction AOI is independent from Format_7 AOI settings.

If you switch off autofunction AOI, work area position and work area size follow the current active image size.

To switch off autofunctions, carry out following actions in the order shown:

1. Uncheck **Show AOI** check box (SmartView **Ctrl2** tab).
2. Uncheck **Enable** check box (SmartView **Ctrl2** tab).
Switch off Auto modi (e.g. **Shutter** and/or **Gain**) (SmartView **Ctrl2** tab).

As a reference it uses a grid of up to 65534 sample points equally spread over the AOI.

Register	Name	Field	Bit	Description
0xF1000390	AUTOFNC_AOI	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..3]	Reserved
		ShowWorkArea	[4]	Show work area
		---	[5]	Reserved
		ON_OFF	[6]	Enable/disable AOI (see note above)
		---	[7]	Reserved
		YUNITS	[8..19]	Y units of work area/pos. beginning with 0 (read only)
		XUNITS	[20..31]	X units of work area/pos. beginning with 0 (read only)
0xF1000394	AF_AREA_POSITION	Left	[0..15]	Work area position (left coordinate)
		Top	[16..31]	Work area position (top coordinate)

Table 151: Advanced register for autofunction AOI

Register	Name	Field	Bit	Description
0xF1000398	AF_AREA_SIZE	Width	[0..15]	Width of work area size
		Height	[16..31]	Height of work area size

Table 151: Advanced register for autofunction AOI

The possible increment of the work area position and size is defined by the YUNITS and XUNITS fields. The camera automatically adjusts your settings to permitted values.

Note

If the adjustment fails and the work area size and/or work area position becomes invalid, then this feature is automatically switched off.

Read back the ON_OFF flag, if this feature does not work as expected.

Color correction

To switch off color correction in YUV mode: see bit [6]

<table>
<tr><th>Register</th><th>Name</th><th>Field</th><th>Bit</th><th>Description</th></tr>
<tr><td rowspan="5">0xF10003A0</td><td rowspan="5">COLOR_CORR</td><td>Presence_Inq</td><td>[0]</td><td>Indicates presence of this feature (read only)</td></tr>
<tr><td>---</td><td>[1..5]</td><td>Reserved</td></tr>
<tr><td>ON_OFF</td><td>[6]</td><td>Color correction on/off
default: on
Write: 02000000h to switch color correction OFF
Write: 00000000h to switch color correction ON</td></tr>
<tr><td>Reset</td><td>[7]</td><td>Reset to defaults</td></tr>
<tr><td>---</td><td>[8..31]</td><td>Reserved</td></tr>
<tr><td>0xF10003A4</td><td>COLOR_CORR_COEFFIC11 = Crr</td><td></td><td>[0..31]</td><td rowspan="9">A number of 1000 equals a color correction coefficient of 1.
Color correction values range -1000..+2000 and are signed 32 bit.
In order for white balance to work properly ensure that the row sum equals to 1000.
The maximum row sum is limited to 2000.</td></tr>
<tr><td>0xF10003A8</td><td>COLOR_CORR_COEFFIC12 = Cgr</td><td></td><td>[0..31]</td></tr>
<tr><td>0xF10003AC</td><td>COLOR_CORR_COEFFIC13 = Cbr</td><td></td><td>[0..31]</td></tr>
<tr><td>0xF10003B0</td><td>COLOR_CORR_COEFFIC21 = Crg</td><td></td><td>[0..31]</td></tr>
<tr><td>0xF10003B4</td><td>COLOR_CORR_COEFFIC22 = Cgg</td><td></td><td>[0..31]</td></tr>
<tr><td>0xF10003B8</td><td>COLOR_CORR_COEFFIC23 = Cbg</td><td></td><td>[0..31]</td></tr>
<tr><td>0xF10003BC</td><td>COLOR_CORR_COEFFIC31 = Crb</td><td></td><td>[0..31]</td></tr>
<tr><td>0xF10003C0</td><td>COLOR_CORR_COEFFIC32 = Cgb</td><td></td><td>[0..31]</td></tr>
<tr><td>0xF10003C4</td><td>COLOR_CORR_COEFFIC33 = Cbb</td><td></td><td>[0..31]</td></tr>
<tr><td>0xF10003A4
...
0xF10003FC</td><td></td><td></td><td></td><td>Reserved for testing purposes
Don’t touch</td></tr>
</table>

Table 152: Color correction

For an explanation of the color correction matrix and for further information read Chapter Color correction on page 165.

Trigger delay

Register	Name	Field	Bit	Description
0xF1000400	TRIGGER_DELAY	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	Reserved
		ON_OFF	[6]	Trigger delay on/off
		---	[7..10]	Reserved
		DelayTime	[11..31]	Delay time in µs

Table 153: Trigger delay advanced CSR

The advanced register allows start of the integration to be delayed via **DelayTime** by max. 2^{21} µs, which is max. 2.1 s after a trigger edge was detected.

Note Trigger delay works with external trigger modes only.

Mirror image

PIKE cameras are equipped with an electronic mirror function, which mirrors pixels from the left side of the image to the right side and vice versa. The mirror is centered to the actual **FOV** center and can be combined with all image manipulation functions, like **binning** and **shading**.

Register	Name	Field	Bit	Description
0xF1000410	MIRROR_IMAGE	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	Reserved
		ON_OFF	[6]	Mirror image on/off 1: on 0: off Default: off
		---	[7..31]	Reserved

Table 154: Mirror control register

AFE channel compensation (channel balance)

All KODAK PIKE sensors are read out via two channels: the first channel for the left half of the image and the second channel for the right half of the image.

Channel gain adjustment (PIKE color cameras only RAW8 and RAW16) can be done via the following two advanced registers:

Register	Name	Field	Bit	Description
0xF1000420	CHANNEL_ADJUST_CTRL	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..7]	Reserved
		Save as default	[8]	Set to 1, if you want to save your own values.
		---	[9..31]	Reserved
0xF1000424	CHANNEL_ADJUST_VALUE	---	[0..15]	Reserved
		Balance_Value	[16..31]	Signed 16 bit value -8192...0...+8191 SmartView shows only: -2048...0...+2047

Table 155: Channel balance register

Soft Reset

Register	Name	Field	Bit	Description
0xF1000510	SOFT_RESET	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	Reserved
		Reset	[6]	Initiate reset
		---	[7..19]	Reserved
		Delay	[20..31]	Delay reset in 10 ms steps

Table 156: Soft reset register

The SOFT_RESET feature is similar to the INITIALIZE register, with the following differences:

- 1 or more bus resets will occur
- the FPGA will be rebooted

The reset can be delayed by setting the **Delay** to a value unequal to 0 - the delay is defined in 10 ms steps.

Note

When SOFT_RESET has been defined, the camera will respond to further read or write requests but will not process them.

High SNR mode (High Signal Noise Ratio)

With **High SNR** mode enabled the camera internally grabs **GrabCount** images and outputs a single averaged image.

Register	Name	Field	Bit	Description
0xF1000520	HIGH_SNR	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	Reserved
		ON_OFF	[6]	High SNR mode on/off
		---	[7..22]	Reserved
		GrabCount	[23..31]	Number of images (min. 2) 2^n images with n=1..8 (automatically)

Table 157: High Signal Noise Ratio (HSNR)

Note

The camera must be idle to toggle this feature on/off.

Quick parameter change timing modes

You can choose between the following update timing modes:

- **Standard Parameter Update Timing** (slightly modified from previous PIKE cameras)
- New: **Quick Format Change Mode**

For a detailed description see Chapter Quick parameter change timing modes on page 151.

Register	Name	Field	Bit	Description
0xF1000570	PARAMUPD_TIMING	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	Reserved
		UpdActive	[6]	Update active Set to 1 and set UpdTiming to 1 to switch on **Quick Format Change Mode**.
		---	[7..23]	Reserved
		UpdTiming	[24..31]	Update timing mode 0: **Standard Parameter Update Timing** is active If set to 1 and also UpdActive is set to 1: **Quick Format Change Mode** is active Integration is stopped. Set your parameters. Then set UpdActive to 0: end of sequence. All new parameters are written to FPGA. Integration is done now with new parameters.

Table 158: Update timing modes

Standard Parameter Update Timing

The camera behaves like older firmware versions without this feature. The **UpdActive** flag has no meaning.

Quick Format Change Mode

This mode behaves like **Standard Parameter Update Timing** mode with the following exception:

An already started image transport to the host will not be interrupted, but an already started integration will be interrupted.

To switch on **Quick Format Change Mode** do the following:

1. Set UpdTiming to 1.
2. Set UpdActive to 1.
3. Be aware that all parameter values have to be set within 10 seconds.

Automatic reset of the UpdActive flag

With **Quick Format Change Mode** you normally have to clear the **UpdActive** flag after all desired parameters have been set. Every time the **PARAMUPD_TIMING** register is written to with the **UpdActive** flag set to 1 a 10 second time-out is started / restarted. If the time-out passes before you clear the **UpdActive** flag, the **UpdActive** flag is cleared automatically and all parameter changes since setting the **UpdActive** flag to 1 become active automatically.

Parameter-List Update

The parameter list is an array of address/data pairs which can be sent to the camera in a single bus cycle.

Register	Name	Field	Bit	Description
0xF1100000	PARAMLIST_INFO	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..15]	Reserved
		BufferSize	[16..31]	Size of parameter list buffer in bytes
0x1101000 ... 0x1101nnn	PARAMLIST_BUFFER			

Table 159: **Parameter-List Update**: parameter list

Dependant on the parameter update mode the address/data pairs may become active one by one or after the processing of the complete parameter list. A parameter list may look like follows (the description is for your convenience):

Address offset	Data quadlet	Description
0xF0F00608	0xE0000000	Set video format 7
0xF0F00604	0x00000000	Set video mode 0
0xF0F08008	0x00000000	Set image position
0xF0F0800C	0x028001E0	Set image size
0xF0F08044	0x04840484	Set BytePerPacket value
0xF0F0080C	0x80000100	Set shutter to 0x100
0xF0F00820	0x80000080	Set gain to 0x80

Table 160: Example: parameter list

Note

- The PARAMLIST_BUFFER shares the memory with the GPDATA_BUFFER. Therefore it is not possible to use both features at the same time.
- Not all CSRs or features of a particular camera model can be used with the parameter list feature.

Format_7 mode mapping

With Format_7 mode mapping it is possible to map special binning and sub-sampling modes to F7M1..F7M7 (see Figure 86: Mapping of possible Format_7 modes to F7M1...F7M7 on page 150).

Register	Name	Field	Bit	Description
0xF1000580	F7MODE_MAPPING	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..31]	Reserved
0xF1000584	F7MODE_MAP_INQ	F7MODE_00_INQ	[0]	Format_7 Mode_0 presence
		F7MODE_01_INQ	[1]	Format_7 Mode_1 presence
		...	...	...
		F7MODE_31_INQ	[31]	Format_7 Mode_31 presence
0xF1000588	Reserved	---	---	---
0xF100058C	Reserved	---	---	---
0xF1000590	F7MODE_0	Format_ID	[0..31]	Format ID (read only)
0xF1000594	F7MODE_1	Format_ID	[0..31]	Format ID for Format_7 Mode_1
0xF1000598	F7MODE_2	Format_ID	[0..31]	Format ID for Format_7 Mode_2
0xF100059C	F7MODE_3	Format_ID	[0..31]	Format ID for Format_7 Mode_3
0xF10005A0	F7MODE_4	Format_ID	[0..31]	Format ID for Format_7 Mode_4
0xF10005A4	F7MODE_5	Format_ID	[0..31]	Format ID for Format_7 Mode_5
0xF10005A8	F7MODE_6	Format_ID	[0..31]	Format ID for Format_7 Mode_6
0xF10005AC	F7MODE_7	Format_ID	[0..31]	Format ID for Format_7 Mode_7

Table 161: Format_7 mode mapping register

Firmware 3.x adds additional Format_7 modes. Now you can add some special Format_7 modes which aren’t covered by the IIDC standard. These special modes implement **binning** and **sub-sampling**.

To stay as close as possible to the IIDC standard the Format_7 modes can be mapped into the register space of the standard Format_7 modes.

There are visible Format_7 modes and internal Format_7 modes:

- At any time only 8 Format_7 modes can be accessed by a host computer.
- Visible Format_7 modes are numbered from 0 to 7.
- Internal Format_7 modes are numbered from 0 to 31.

Format_7 Mode_0 represents the mode with the maximum resolution of the camera: this visible mode cannot be mapped to any other internal mode.

The remaining visible Format_7 Mode_1 ... Mode_7 can be mapped to any internal Format_7 mode.

Example

To map the internal Format_7 Mode_19 to the visible Format_7 Mode_1, write the decimal number 19 to the above listed F7MODE_1 register.

Note

For available Format_7 modes see Figure 86: Mapping of possible Format_7 modes to F7M1...F7M7 on page 150.

Setting the F7MODE_x register to:

- -1 forces the camera to use the factory defined mode
- -2 disables the respective Format_7 mode (no mapping is applied)

After setup of personal Format_7 mode mappings you have to reset the camera. The mapping is performed during the camera startup only.

Secure image signature (SIS)

Secure image signature (SIS) is the synonym for data, which is inserted into an image to improve or check image integrity.

All PIKE models can insert

- **Time stamp** (1394 bus cycle time at the beginning of integration)
- **Frame counter** (frames read out of the sensor)
- **Trigger counter** (external trigger seen only)
- Various camera settings

into a selectable line position within the image. **Frame counter** and **trigger counter** are available as advanced registers to be read out directly.

Advanced register: SIS

The **SIS** feature is controlled by the following advanced feature register:

Note

This register is **different** to the MARLIN **Timestamp** (600) register!

Register	Name	Field	Bit	Description
0xF1000630	SIS	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	Reserved
		ON_OFF	[6]	SIS mode on/off
		---	[7.. 15]	Reserved
		LineNo	[16..31]	SIS data position inside an image
0xF1000634		UserValue	[0..31]	User provided value for sequence mode to be placed into the SIS area of an image

Table 162: Advanced register: **SIS**

Enabling this feature, SIS data will be inserted into any captured image. The size of SIS data depends on the selected SIS format.

The **LineNo** field indicates at which line the SIS data will be inserted.

Enter a

- **positive value** from 0..HeightOfImage to specify a position relative to the top of the image. LinePos=0 specifies the very first image line.
- **negative value** from -1..-HeightOfImage to specify a position relative to the bottom of the image. LinePos=-1 specifies the very last image line.

SIS **UserValue** can be written into the camera's image. In sequence mode for every sequence entry an own SIS **UserValue** can be written.

Note

SIS outside the visible image area:

For certain Format_7 modes the image frame transported may contain padding (filling) data at the end of the transported frame. Setting LinePos=HeightOfImage places the stamp in this padding data area, outside the visible area (invisible SIS).

If the transported image frame does not contain any padding data the camera will not relocate the SIS to the visible area automatically (no SIS).

Take in mind that the accuracy of the time stamp might be affected by asynchronous traffic – mainly if image settings are changed.

Note

The IEEE 1394 **cycle counter** (aka **time stamp**) will be inserted into the **very first 4 bytes/pixels of a line**.

Cycle offset	Cycles	Seconds
Cycle offset 12 bit	Cycle count 13 bit	Second count 7 bit
0 .. 3071 cycle offsets (40.69 ns)	0 .. 7999 cycles	0 .. 127 seconds
24.576 MHz cycle timer counter	8000 Hz cycle timer counter	1 Hz cycle timer counter

Table 163: 32-bit cycle timer layout

Bit	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Cycle offset 12 bit												Cycle count ...			

Bit	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
	... Cycle count 13 bit									Second count 7 bit						

Table 164: Cycle timer layout

Advanced register: frame counter

Different to Marlin SIS: Register 610 is only to be used to reset the frame counter. The **frame counter** feature is controlled by the following advanced feature register:

Register	Name	Field	Bit	Description
0xF1000610	FRMCNT_STAMP	Presence_Inq	[0]	Indicates presence of this feature (read only)
		Reset	[1]	Reset frame counter
		---	[2..31]	Reserved
0xF1000614	FRMCNT		[0..31]	Frame counter

Table 165: Advanced register: frame counter

Having this feature enabled, the current **frame counter** value (images read out of the sensor, equivalent to # FrameValid) will be inserted as a 32-bit integer value into any captured image.

Setting the **Reset** flag to 1 resets the frame counter to 0 — the **Reset** flag is self-cleared.

Note

The 4 bytes of the **frame counter** value will be inserted as the **5th to 8th byte of a line**.

Additionally there is a register for direct read out of the frame counter value.

Advanced register: trigger counter

The **trigger counter** feature is controlled by the following advanced feature register:

Register	Name	Field	Bit	Description
0xF1000620	TRIGGER_COUNTER	Presence_Inq	[0]	Indicates presence of this feature (read only)
		Reset	[1]	Reset trigger counter
		---	[2..31]	Reserved
0xF1000624	TRGCNT	TriggerCounter	[0..31]	Trigger counter

Table 166: Advanced register: trigger counter

Having this feature enabled, the current **trigger counter** value (external trigger seen by hardware) will be inserted as a 32-bit integer value into any captured image.

Setting the **Reset** flag to 1 resets the **trigger counter** to 0 – the Reset flag is self-cleared.

The **ON_OFF** and **LinePos** fields are simply mirrors of the time stamp feature. Settings of these fields are applied to all image stamp features.

Note

The 4 bytes of the **trigger counter** value will be inserted as the **9th to 12th byte of a line**.

Additionally there is a register for direct read out of the **trigger counter** value.

Where to find time stamp, frame counter and trigger counter in the image

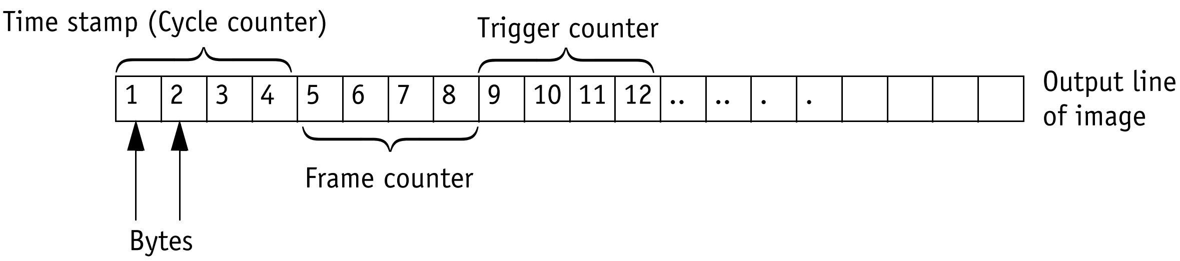


Figure 115: SIS in the image

Where to find all SIS values in the image

In the following table you find the position of all SIS values byte for byte including the endianness of SIS values.

CycleCounter [7..0]	CycleCounter [15..8]	CycleCounter [23..16]	CycleCounter [31..24]
Byte 1	Byte 2	Byte 3	Byte 4
FrameCounter [7..0]	FrameCounter [15..8]	FrameCounter [23..16]	FrameCounter [31..24]
Byte 5	Byte 6	Byte 7	Byte 8
TriggerCounter [7..0]	TriggerCounter [15..8]	TriggerCounter [23..16]	TriggerCounter [31..24]
Byte 9	Byte 10	Byte 11	Byte 12
AoiLeft [7..0]	AoiLeft [15..8]	AoiTop [7..0]	AoiTop [15..8]
Byte 13	Byte 14	Byte 15	Byte 16
AoiWidth [7..0]	AoiWidth [15..8]	AoiHeight [7..0]	AoiHeight [15..8]
Byte 17	Byte 18	Byte 19	Byte 20
Shutter [7..0]	Shutter [15..8]	Shutter [23..16]	Shutter [31..24]
Byte 21	Byte 22	Byte 23	Byte 24
Gain [7..0]	Gain [15..8]	Reserved [NULL]	Reserved [NULL]
Byte 25	Byte 26	Byte 27	Byte 28
OutputState_1 [7..0]	OutputState_2 [7..0]	OutputState_3 [7..0]	OutputState_4 [7..0]
Byte 29	Byte 30	Byte 31	Byte 32
InputState_1 [7..0]	InputState_2 [7..0]	Reserved [NULL]	Reserved [NULL]
Byte 33	Byte 34	Byte 35	Byte 36
SequenceIndex [7..0]	Reserved [NULL]	ColorCoding [NULL]	Reserved [NULL]
Byte 37	Byte 38	Byte 39	Byte 40
SerialNumber [7..0]	SerialNumber [15..8]	SerialNumber [23..16]	SerialNumber [31..24]
Byte 41	Byte 42	Byte 43	Byte 44
SIS_UserValue [7..0]	SIS_UserValue [15..8]	SIS_UserValue [23..16]	SIS_UserValue [31..24]
Byte45	Byte46	Byte47	Byte48

Table 167: SIS values (increasing order of transmitted pixels)

Smear reduction

To enable/disable smear reduction use the following register(s):

Register	Name	Field	Bit	Description
0xF1000440	LOW_SMEAR	Presence_Inq	[0]	Indicates presence of this feature (read only)
		--	[1..5]	Reserved
		ON_OFF	[6]	Smear reduction on/off
		--	[7..31]	Reserved

Table 168: Register for smear reduction

User profiles

Within the IIDC specification user profiles are called memory channels. Often they are called user sets. In fact these are different expressions for the following: storing camera settings into a non-volatile memory inside the camera.

Offset	Name	Field	Bit	Description
0x1000550	USER_PROFILE	Presence_Inq	[0]	Indicates presence of this feature (read only)
		Error	[1]	An error occurred
		---	[2..6]	Reserved
		Busy	[7]	Save/Load in progress
		Save	[8]	Save settings to profile
		Load	[9]	Load settings from profile
		SetDefaultID	[10]	Set Profile ID as default
		---	[11..19]	Reserved
		ErrorCode	[20..23]	Error code See Table 170: User profiles: Error codes on page 318.
		---	[24..27]	Reserved
		ProfileID	[28..31]	ProfileID (memory channel)

Table 169: User profiles

In general this advanced register is a wrapper around the standard memory channel registers with some extensions. So to query the number of available user profiles you have to check the **Memory_Channel** field of the **BASIC_FUNC_INQ** register at offset **0x400** (see IIDC V1.31 for details).

The **ProfileID** is equivalent to the memory channel number and specifies the profile number to store settings to or to restore settings from. In any case profile #0 is the hard-coded factory profile and cannot be overwritten.

After an initialization command, startup or reset of the camera, the **ProfileID** also indicates which profile was loaded on startup, reset or initialization.

Note

- The default profile is the profile that is loaded on power-up or an INITIALIZE command.
- A save or load operation delays the response of the camera until the operation is completed. At a time only one operation can be performed.

To store the current camera settings into a profile:

1. Write the desired **ProfileID** with the **SaveProfile** flag set.
2. Read back the register and check the **ErrorCode** field.

To restore the settings from a previous stored profile:

1. Write the desired **ProfileID** with the **RestoreProfile** flag set.
2. Read back the register and check the **ErrorCode** field.

To set the default profile to be loaded on startup, reset or initialization

1. Write the desired **ProfileID** with the **SetDefaultID** flag set.
2. Read back the register and check the **ErrorCode** field.

Error codes

ErrorCode #	Description
0x00	No error
0x01	Profile data corrupted
0x02	Camera not idle during restore operation
0x03	Feature not available (feature not present)
0x04	Profile does not exist
0x05	ProfileID out of range
0x06	Restoring the default profile failed
0x07	Loading LUT data failed
0x08	Storing LUT data failed

Table 170: User profiles: Error codes

Reset of error codes

The **ErrorCode** field is set to zero on the next write access.

You may also reset the **ErrorCode**

- by writing to the **USER_PROFILE** register with the **SaveProfile**, **RestoreProfile** and **SetDefaultID** flag not set.
- by writing 00000000h to the **USER_PROFILE** register.

Stored settings

The following table shows the settings stored inside a profile:

Standard registers	Standard registers (Format_7)	Advanced registers
Cur_V_Frm_Rate Cur_V_Mode Cur_V_Format ISO_Channel ISO_Speed BRIGHTNESS AUTO_EXPOSURE (Target grey level) SHARPNESS WHITE_BALANCE (+ auto on/off) HUE (+ hue on) SATURATION (+ saturation on) GAMMA (+ gamma on) SHUTTER (+ auto on/off) GAIN TRIGGER_MODE TRIGGER_POLARITY TRIGGER_DELAY ABS_GAIN	IMAGE_POSITION (AOI) IMAGE_SIZE (AOI) COLOR_CODING_ID BYTES_PER_PACKET	TIMEBASE EXTD_SHUTTER IO_INP_CTRL IO_OUTP_CTRL IO_INTENA_DELAY AUTOSHUTTER_CTRL AUTOSHUTTER_LO AUTOSHUTTER_HI AUTOGAIN_CTRL AUTOFNC_AOI (+ on/off) COLOR_CORR (on/off + color correction coefficients) TRIGGER_DELAY MIRROR_IMAGE HIGH_SNR LUT_CTRL (LutNo; ON_OFF is not saved) SHDG_CTRL (on/off + ShowImage) DEFERRED_TRANS (HoldImg + NumOfImages) CHANNEL_ADJUST_CTRL CHANNEL_ADJUST_VALUE

Table 171: User profile: stored settings

The user can specify which user profile will be loaded upon startup of the camera.

This frees the user software from having to restore camera settings, that differ from default, after every cold start. This can be especially helpful if third party software is used which may not give easy access to certain advanced features or may not provide efficient commands for quick writing of data blocks into the camera.

Note

- A profile save operation automatically disables capturing of images.
- A profile save or restore operation is an uninterruptable (atomic) operation. The write response (of the asynchronous write cycle) will be sent after completion of the operation.
- Restoring a profile will not overwrite other settings than listed above.
- If a restore operation fails or the specified profile does not exist, all registers will be overwritten with the hard-coded factory defaults (profile #0).
- Data written to this register will not be reflected in the standard memory channel registers.

GPDATA_BUFFER

GPDATA_BUFFER is a general purpose register that regulates the exchange of data between camera and host for:

- writing look-up tables (LUTs) into the camera
- uploading/downloading of the shading image

GPDATA_INFO Buffer size query

GPDATA_BUFFER indicates the actual storage range

Register	Name	Field	Bit	Description
0xF1000FFC	GPDATA_INFO	---	[0..15]	Reserved
		BufferSize	[16..31]	Size of GPDATA_BUFFER (byte)
0xF1001000 ... 0xF10017FC	GPDATA_BUFFER			

Table 172: GPData buffer register

Note

- Read the BufferSize before using
- GPDATA_BUFFER can be used by only one function at a time.

Firmware update

Firmware updates can be carried out via FireWire cable without opening the camera.

Note

For further information:

- Read the application note: **How to update Guppy/Pike firmware** at AVT website or
- Contact your local dealer.

Extended version number (FPGA/µC)

The new extended version number for microcontroller and FPGA firmware has the following format (4 parts separated by periods; each part consists of two digits):

Special.Major.Minor.Bugfix

or

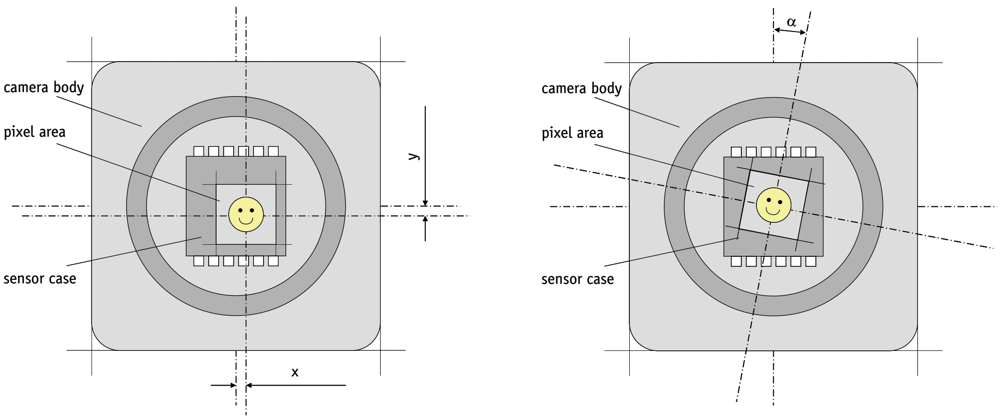
xx.xx.xx.xx

Digit	Description
1st part: Special	Omitted if zero Indicates customer specific versions (OEM variants). Each customer has its own number.
2nd part: Major	Indicates big changes Old: represented the number before the dot
3rd part: Minor	Indicates small changes Old: represented the number after the dot
4th part: Bugfix	Indicates bugfixing only (no changes of a feature) or build number

Table 173: New version number (microcontroller and FPGA)

Appendix

Sensor position accuracy of AVT cameras



AVT Guppy Series

Method of Positioning:	Automated mechanical alignment of sensor into camera front module. (lens mount front flange)		
Reference points:	Sensor: Center of pixel area (photo sensitive cells). Camera: Center of camera front flange (outer case edges).		
Accuracy:	x/y:	+/- 0.25mm	(Sensor shift)
	z:	+50 / -100µm	(for SN > 84254727, optical back focal length)
		+0 / -100µm	(for SN > 252138124, optical back focal length)
	α:	+/- 1°	(Sensor rotation)

AVT Marlin, Oscar, Dolphin, Pike

Method of Positioning:	Optical alignment of photo sensitive sensor area into camera front module. (lens mount front flange)		
Reference points:	Sensor: Center of pixel area (photo sensitive cells). Camera: Center of camera front flange (outer case edges).		
Accuracy:	x/y:	+/- 0.1mm	(Sensor shift)
	z:	+0 / -50µm	(Optical back focal length)
	α:	+/- 0.5°	(Sensor rotation)

Note: x/y - tolerances between c-Mount hole and pixel area may be higher.

Figure 116: AVT sensor position accuracy

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